The
Tropical Agriculturist
April, 1936

EDITORIAL

THE CONTROL OF FRUIT-TREE PESTS

LOCAL fruit-growers have been supplied at various times in this Journal with information on the different aspects of fruit-cultivation, and in this number appears the first part of some notes on the commoner insect pests known to attack fruit-trees and their crops in Ceylon. This part deals with the better known pests of citrus and mango, which are perhaps the most important and popular representatives of local fruits, and indicates certain control measures to be adopted by fruit-growers if they are to get the best results from their trees. It so happens that varieties of citrus, such as orange and grape-fruit, and different kinds of mangoes are almost the only groups of fruit-trees in Ceylon which are attacked by a large number of pests and diseases. These enemies not only take their toll of the blossoms and fruit, but tend to cripple the normal growth of the trees, if neglected, and it is usually the better imported varieties which suffer most.

These conditions must be realised by local fruit-growers and those who have already started citrus or mango orchards or both must be prepared to set aside every year a definite sum for the control of the various pests and diseases which will inevitably attack their trees and crops in whatever part of the Island they choose to settle. The control of pests and diseases is bound to involve this recurrent expenditure, since many of these can only be kept down by the regular and systematic

application of insecticides and fungicides. The application of these chemicals also involves the purchase and upkeep of spraying equipment and the special training of labour. The fight against pests and diseases starts from the time that the young grafted plants are put out and spraying should be adopted as a routine measure from the beginning and may be regarded as a form of insurance.

The production of first-class fruit in a clean and sound condition should prove a profitable venture, provided that suitable markets are available, and it should be emphasised that this result can only be attained by regular attention to details of pest and disease control in conjunction with the necessary cultural measures. Fruit-growing on modern lines is a highly specialised industry and successful control of fruit-tree enemies is by no means the least important aspect of the business.

ENTOMOLOGICAL NOTES—I.

SOME COMMON INSECT PESTS OF FRUIT TREES

CONTRIBUTIONS FROM THE ENTOMOLOGICAL DIVISION, PERADENIYA, CEYLON

OUR records and correspondence files indicate that both the leaves and fruit of citrus, mango and other fruit-trees in Ceylon, especially the better imported grafted plants, suffer continuously from the ravages of various insect pests. It seems desirable, therefore, at a time when considerable interest is being taken in fruit production, to bring together some brief notes on these pests with which fruit-growers usually have to contend and which must be controlled if vigorous and well-shaped trees are to be produced and satisfactory crops of sound and clean fruit are to be obtained.

CITRUS PESTS

FRUIT-FLIES

Fruit-flies usually visit fruit for oviposition purposes a few weeks before the ripening process starts. The eggs are laid in the fruit, the female puncturing the rind and pith with her long extensible ovipositor and placing the eggs just inside the pith in the flesh. The punctures are scarcely visible except under a lens and are not nearly so conspicuous as those made by the fruit-piercing moths mentioned elsewhere.

The eggs usually hatch within one week and the maggots tunnel about inside the fruit, causing it to decay and sometimes to drop prematurely. The maggots are full-grown in about 1 to 2 weeks and then emerge from the fruit and enter the soil to form their puparia or cocoons, usually about 2 inches below the surface. Maggots emerging from fallen fruit usually pupate in the soil under or near the fruit. The pupal stage lasts from 1 to 2 weeks, after which the flies emerge. The common citrus fruit-fly in Ceylon is *Dacus ferrugineus*, a medium-sized rather slender brownish insect with one pair of clear wings and a pale yellow band edged with black across the middle of the abdomen.

Control.—Fruit-flies require food before mating and oviposition. The main principle of the control of these pests is,

therefore, to attract the females to poisoned baits before they are able to lay their eggs in the fruit. The following poisoned bait, if made up and exposed as directed below, should attract and kill many of the female flies :—

Arsenate of lead ..	..	½ oz.
Cheap Sugar or Jaggery	..	12 oz.
Water	..	10 pints

To prepare the bait, add a little water to the arsenate of lead powder and mix to a paste. Then dissolve the sugar in a little of the water and stir this and the paste into the remainder of the water. This syrup should be placed in cigarette tins and hung up in the branches of the trees requiring protection and to any convenient place around the trees. If the tops of the tins are provided with three V-cuts, the lid may be replaced to keep out the rain. Wires can then be inserted into the spaces between the cuts for the purpose of hanging the tin. Pieces of lamp wick, or stout cloth, should be arranged with one end in the liquid in the tin and the other end hanging slightly through the slots, but not low enough to siphon out the liquid. The bait tins should be renewed periodically when they become too rusty and the liquid can be replenished as required.

This bait may also be applied to the trees themselves with an ordinary garden syringe. The solution should be squirted into the air so as to fall upon the foliage in fine drops and, in applying, the operator should walk around the tree so as to insure an even distribution of the spray. The bait should be applied about one month before the first fruit is expected to ripen and should be repeated at intervals of about one week until all the fruit is off the trees. Fresh applications should also be given after heavy rain.

It is most important that all fallen fruit should be collected and destroyed daily, either by boiling in kerosene tins, or by throwing the fruit into water until it starts fermenting. The object of these measures is to prevent the emergence of the next generation of flies, since fallen fruit is certain to contain the maggots of the fly. If fallen fruit is not destroyed early, the maggots will leave the fruit, pupate in the soil and in due course give rise to the next generation of flies.

FRUIT-PIERCING MOTHS

The ripening fruit of oranges is not uncommonly damaged by conspicuous punctures, mainly in low-country districts, and this injury is sometimes wrongly attributed to the action of thorns when the fruit is blown against them in high winds. The punctures are frequently made by the proboscis of a large moth which pierces the fruit and sucks the juice, the damage being done usually at night when the moths are active. Punctured fruit turns rotten and drops. The two commoner species are *Othreis* (*Ophideres*) *salaminia* and *O. fullonica*. They are large-bodied insects with a wing expanse of about 3 to 3½ inches. They mostly have orange-yellow underwings with a kidney-shaped dark spot in the centre of each wing and dark margins. The forewings may be brown or green according to the species.

The caterpillars of these moths have nothing to do with citrus, but are said to feed on the leaves of *Quisqualis indica*, sometimes known as the " Rangoon creeper " ; they also feed on wild creepers such as *Cyclea* and other Menispermaceae. Damage by the moths has been reported only between December and February and so far only to oranges, but it is not unlikely that other citrus fruits, such as grape-fruit, are also attacked.

Control.—The poisoned bait mentioned above for fruit-fly would also be useful against these moths. In India the moths are sometimes caught with hand-nets at night while they are attacking the fruit.

CITRUS BUTTERFLIES

The leaves of various kinds of citrus, such as orange, grape-fruit, etc., are frequently attacked by the larvae, or caterpillars, of two species of large butterflies (*Papilio demoleus* and *Papilio polytes*), the larvae of both species closely resembling each other in general appearance. Young plants are sometimes stripped bare by the older larvae. Other related plants belonging to the Rutaceae, such as curry leaf (*Murraya Koenigii*) and wood-apple (*Feronia elephantum*) are also attacked.

The pale green to yellowish, globular eggs are laid singly on the leaves, and the larvae in various stages of development feed quite conspicuously. The younger larvae is protected by its resemblance to a bird's dropping. The full-grown larvae is a deep olive green with brown and white markings. The caterpillars when disturbed, suddenly thrust out a pair of

fleshy "horns" from behind the head; these protuberances exude a very pungent odour, which serves to protect the larvae from birds, etc. The larval stage lasts about 2 weeks.

Before changing into the pupa, or chrysalis, the larvae attaches itself to a twig or leaf. The chrysalis may be either brownish or greenish according to its surroundings and is slung by a girdle of silken threads. The butterfly emerges from its chrysalis after about 2 weeks.

Control.—The young larvae are usually controlled by the nicotine-soap spray recommended elsewhere for leaf-miner, while the older larvae and chrysalides can be hand-picked and destroyed. Periodical spraying with lead arsenate at the rate of 1 lb. to 2 gallons of water, will also control these pests if they become too numerous.

TWO SMALL CATERPILLAR PESTS OF CITRUS

As indicated in a previous article,* the normal growth of citrus plants in Ceylon is often seriously crippled by the combined attacks of two small caterpillars, the leaf-miner and the leaf-roller, and both these insects are essentially pests of young plants. Reference may be made to this article for fuller details.

The leaf-miner (*Phyllocnistis citrella*) is a very small caterpillar which feeds inside the young leaves, making irregular galleries and leaving the epidermis as a silvery film. The leaves become distorted and never develop normally.

The leaf-roller (*Psorosticha zizyphi*) lives on the surfaces of the younger leaves, webbing these together or rolling them up and feeding here and there. These small caterpillars wander about freely and even a few of them can spoil the appearance of a young plant, all the younger leaves and shoots being bitten off or rolled up as they appear.

These two pests are not uncommonly found together on the same young plants, which fail to develop normally and are readily exposed to infection by citrus mildew and canker.

Control.—The following spray mixture is recommended for young citrus plants during the first few years of their growth, and if applied regularly at least twice a month, or more frequently during the production of young leaves, will help to keep the

*Two Caterpillar Pests of Citrus. *Trop. Agriculturist*, LXXXIII, No. 3, pp. 188-193, 2 col. plates. Reprints may be obtained from the Propaganda Officer, Peradeniya.

plants clean and vigorous and free from most leaf-eating pests and from sucking insects, such as scales and aphids. The nicotine and soap are insecticides, while fungus diseases, such as mildew, are controlled by the colloidal sulphur.

Nicotine Sulphate	..	2 oz.
Colloidal Sulphur	..	4 oz.
Soft or Yellow Soap	..	4 oz.
Water	..	4 gallons

The soap is dissolved first in a little water, soft soap (not carbolic) being preferable, since it dissolves more easily. If hard yellow soap is used it should be shaved off into thin slices so that it may dissolve more rapidly. Add the remainder of the water, stirring gently, and then stir in the other ingredients. Spraying should be done preferably in the early morning or late afternoon. For fuller information, see general notes on spraying, etc., at the end of part two of these notes.

SUCKING INSECTS

The leaves, twigs and sometimes the fruit of various kinds of citrus especially the older trees, are frequently attacked by different species of small sucking insects, and as scales, mealy bugs, " black fly " and aphids. The presence of one or more of these species in large numbers on plants already crippled by leaf-eating pests has a further weakening effect, and unless measures are taken to control them, the health of the plants and the quality of the fruit become seriously impaired. Only brief notes are given here, but fuller information about each individual pest can be obtained from the Entomologist, Peradeniya.

Scale Insects.—Several species of scale insects and mealy-bugs (family Coccidae) may sometimes be found on orange, grape-fruit, lime, and other citrus varieties in Ceylon. None of them are serious pests at present, since they are periodically controlled by insect and fungus parasitic enemies. Perhaps the commonest citrus scales are the green scale (*Coccus viridis*), or " green bug " of tea and coffee, and the mussel-shell scales, (*Lepidosaphes* spp.). The former attacks the leaves, settling down on either side of the mid-rib, and sometimes clusters thickly on the tender twigs. The latter occur on the leaves and sometimes disfigure the fruit.

The citrus red scale *Chrysomphalus* (*Aspidiotus*) *aurantii*, the fluted scale (*Icerya purchasi*) and the citrus mealy-bug

(*Pseudococcus citri*), well known in larger citrus-growing countries are occasionally found on citrus in Ceylon, without assuming the status of pests.

"*Black Fly.*"—Another family of small sucking insects, the Aleyrodidae, commonly known as "white flies," also contains species which are blackish in colour and sometimes called "black flies." The citrus "black flies" in Ceylon mostly belong to the genus *Aleurocanthus*, the two common species being *A. citriperdus* and *A. woglumi*. The immature stages are brownish, while the pupa cases are somewhat hemispherical, oval, deep black, covered with minute spines and edged with a cotton wax fringe. They settle down in patches on the leaves, usually the underside, like scale insects.

All the above kinds of small insects usually settle down on various tender portions of the plants and suck up the plant juices with their slender thread-like beaks. When numerous they cause a considerable drain on the vitality of the plants.

Aphids or Plant-Lice.—The common citrus aphid in Ceylon is *Toxoptera aurantii*, also a minor pest of tea and cacao. These are small dark brown to blackish insects which feed actively in clusters on the tender shoots of citrus, causing the developing leaves to become curled and distorted. They have a winged stage at certain times of the year.

Sometimes the most conspicuous feature of an attack of scale insects, "black fly," aphids, etc., is the presence of a black film on the upper surfaces of the leaves. This film is a fungus known as "sooty mould". This does not cause disease, but develops in the liquid secretions given off by these insects. It will gradually disappear after the insects are killed by spraying.

Control.—All these small sucking insects can be controlled on young trees by the regular application of the combined spray mixture recommended previously for leaf-miner, etc., and small orchards of young trees which have been sprayed periodically from the start should be reasonably free from the attentions of these pests. Older trees of some particularly good variety, which have had no spraying and which may have become heavily infested with green bug and other small sucking insects, should be given special attention. All dead wood and heavily infested branches should first be pruned back and burnt ; in some cases a fairly drastic pruning may be necessary. Then a special course of spraying should be given to get rid of any scales, etc. The sooty mould which usually accompanies such attacks will

disappear gradually after the insects are killed. The following alternative spray mixtures are recommended.

1. Dissolve 4 oz. of soft soap, or hard yellow soap shaved fine, in every 4 gallons of water, and stir in 4 oz. of a concentrated ready-made oil emulsion containing a small percentage of nicotine.

2. Home-made kerosene emulsion, prepared according to the following formula :—

Yellow Bar Soap	½ lb.
Soft Water	1 gallon
Kerosene	2 gallons

Dissolve the soap in the water by shaving it into hot water over a fire. Remove vessel from fire and add the kerosene, stirring thoroughly. Then churn up the mixture by drawing it up into a garden syringe and forcing it back into the vessel. Keep this up until the mixture becomes creamy and begins to thicken. If it does not thicken fairly soon it may mean that the water is too hard. Add a little borax or soda to soften the water, but this should be done at the start if no rain water is available and the local water is known to be hard. The mixing is completed when the creamy mass begins to go hard through the pump. If no syringe is available the mixture can be beaten up with a bunch of stout twigs, but this takes longer and is not so efficient. Unless a thorough emulsion is obtained a small amount of free kerosene will be left which will burn the foliage. The resulting cream or emulsion is the stock solution, and for applying to the trees mix 1 part of the stock with about 9 or 10 parts of water.

MANGO PESTS

FRUIT-FLIES AND FRUIT-PIERCING MOTHS

These two groups of insects have already been noted as pests of citrus fruits and it so happens that mango fruits are attacked by the same species of insects in each group. That is to say, *Dacus ferrugineus* is the common mango fruit-fly and *Othreis salaminia* is the species of moth which pierces ripening mango fruits. The poisoned bait recommended under citrus can also be used against the same pests attacking mango fruits. We now pass on to another fruit pest which is peculiar to mango, so far as is known.

THE MANGO SEED-WEEVIL

It sometimes happens that on cutting open a ripe mango the seed is found to have been partially destroyed by some bor-

ing insect, while the portions of the flesh are discoloured and rotting. This type of injury is caused by the grub of the mango seed-weevil (*Cryptorhynchus mangiferae*), an insect which is widely distributed throughout the East. The adult weevil is about 8 m.m. long, dark greyish brown, and stoutly built, with a strong curved proboscis ; when disturbed it draws in its legs close to the body and shams death.

The weevil lays its eggs in the flesh of young to half-grown fruits and the young grub bores into the tender seed within which it feeds, eventually changing into the pupa and then into the weevil within the seed. The whole life-cycle occupies about 8 weeks. Portions of the flesh may become rotten and the fruit may drop prematurely. Sometimes the seed may be almost entirely destroyed if more than one grub develops in a single seed. The weevils may emerge from the seed before the fruit is picked or they may remain inside for a longer period and only come out after the fruit has been eaten and the seed is discarded. The weevils can usually survive until the next mango season. In captivity they can live for at least 4 months without food. Under natural conditions in India they have been found feeding on the young shoots and leaves of mango.

Control.—Since this insect passes the whole of its early life inside the seed and there is often no external evidence of injury, there seems to be no practicable method of destroying it and reducing its numbers except by collecting and destroying all fallen fruits, as recommended for fruit-fly. Possibly the poisoned bait may also attract and kill the weevils.

TWO MANGO LEAF-WEEVILS

Young mango leaves are frequently eaten by various species of beetles, among which two small weevils have merited special attention some two years ago. The results of the preliminary investigations were published at the time* and reference may be made to the article by those requiring fuller information. It has been thought desirable at this time to emphasise the danger of these small weevils to those who are starting young mango plantations, in view of the serious damage they can do when numerous in any given area.

Leaf-cutting weevil (*Deporaus marginatus*). These are quite inconspicuous little weevils about 5 m.m. long, but it only takes a few of them some two or three hours to cut off every

*Two Weevil Pests of Mango Leaves. *Trop. Agriculturist*, LXXXIII, No. 3, pp. 128-135, 2 col. plates. Reprints may be obtained from the Propaganda Officer, Peradeniya.

leaf in a head of young leaves, having previously laid their eggs in the mid-ribs of the cut portions which fall to the ground. The small grubs feed as leaf-miners within the withering cut portions and are able to complete their development within leaves which are quite shrivelled, provided there is sufficient moisture. They come out and pupate in the soil, emerging as weevils in about 3½ weeks after the eggs are laid. The weevils also damage young leaves by eating away small portions of the epidermis and badly attacked leaves may shrivel up and die. Eggs are laid again within a week after the emergence of the weevils which are able to breed rapidly during the periods of leaf production.

Control.—As soon as the first sign of leaf-spotting or cutting of leaves is noticed, spray the trees, especially the young foliage, with lead arsenate at the rate of 1 oz. to every 2 gallons of water. Collect all cut leaves daily from the ground under the trees and burn immediately to prevent further development of the eggs and grubs.

Flea-weevil (*Rhynchaenus mangiferae*). This is a very small oval brownish insect about 1/10 in. long. When numerous the weevils feed in clusters on the young leaves which become badly spotted and eventually turn brown and die. When disturbed, the weevils jump away in all directions. The entire immature life of this pest is passed within the leaf tissues. The eggs are deposited within the tissues and the small grubs feed as leaf-miners, causing blotches near the edges of young leaves. The pupae are formed within small cells in a portion of the blotch. The complete life-cycle is only about 9 or 10 days in captivity at Peradeniya and the pest increases rapidly while young foliage is available.

Control.—Start spraying with the lead arsenate mixture as soon as an attack is noticed. In dry zone areas where this weevil is known to be a pest it is advisable to spray as soon as the young leaves begin to appear so as to prevent attack. Remove and burn all badly attacked leaves so as to destroy all immature stages.

SUCKING INSECTS

Scale Insects, etc.—The leaves and twigs of mango trees are sometimes attacked by various species of scale insects and mealy-bugs, the presence of which is usually not noticed until the sooty mould has made its appearance. Scale-infested trees can be sprayed with an oil emulsion, where necessary.

The mango capsid (*Disphinctus humeralis*). These are rather slender dark brown plant-sucking bugs about 6-8 m.m. long. These bugs puncture the tender leaves of mango and other plants, causing numerous brownish angular spots which are quite distinct from the smaller rounded spots made by the leaf-eating weevils mentioned above. This spotting is done by all stages of the bugs and it is usually the nymphs which cause the most serious injury in that the leaves usually shrivel up entirely. The young nymphs bear a superficial resemblance to red ants, and often hide within the folds of crinkled leaves during the day.

The females begin egg-laying within a week after emergence and insert their minute, slender, whitish eggs singly into the leaf-stalks and other tender portions of the shoots. The egg-cap is provided with two whitish clubbed hairs, one longer than the other, which project above the surface and incidentally mark the position of each egg. These hairs are scarcely visible except under a lens. The eggs hatch in about 10 to 12 days and the nymphs pass through 5 instars, or periods of feeding and growth between moults, before attaining the adult winged stage in about 12 to 14 days. *Disphinctus* feeds on a great variety of wild and cultivated plants and seems to be widely distributed throughout the Island. It is occasionally a pest of young grafted mango plants and is a difficult insect to control. The adults take wing at the slightest disturbance, while the nymphs usually escape rapidly in all directions. This bug can breed up on many alternate host plants and attack mango, while the young leaves are being produced. Repeated applications of an oil emulsion spray may be necessary at such times in localities where *Disphinctus* becomes numerous. The destruction of wild host plants is also advisable. Among the alternate host plants may be mentioned the following:—*Abutilon* spp.; *Acalypha* spp.; chilli, *Capsicum annum*; shoe-flower (*Hibiscus rosa-sinensis*); *Malraviscus arboreus*; *Osbeckia aspera*; avocado pear (*Persea gratissima*); betel (*Piper Betle*) guava (*Psidium Guajava*); *Solanum* spp.; and grape vine (*Vitis vinifera*). Wild related species of some of the above plants are also attacked.

The mango jassids (*Idiocerus niveosparsus* and *I. clypealis*). These two species of small plant-sucking bugs, commonly known as "leaf-hoppers" are mainly responsible for the so-called "blossom-blight" of mangoes in most countries where this fruit is grown on a commercial scale. So far they have

not occurred as serious pests in Ceylon, except occasionally in the Jaffna district, and no special study has been made of their habits and life-history under local conditions nor have any special control measures been undertaken. The two species are quite distinct in appearance, *niveosparsus* being a larger brown insect about 4·5 m.m. long, while *clypealis* is smaller and pale greenish, about 3·5 m.m. in length. Both these pests have received a thorough investigation in the Philippines* where they are frequently serious pests. The damage caused is of two kinds, (1) the puncturing of the flower buds and shoots for egg-laying, and (2) the feeding punctures of thousands of nymphs on the flowering shoots; in both cases the injured tissues wither and die and much of the fruit fails to set. In serious outbreaks the amount of liquid honey dew excreted by the insects is so great that the flowers are completely covered and rendered incapable of setting fruit. Both species have a short life-cycle, *niveosparsus* completing its development in about 11½ days, while *clypealis* takes about 14 days under Philippine conditions. These leaf-hoppers are able to breed rapidly during the whole flowering season, since two or more broods can be completed while the flower shoots are developing and two more during the actual blossoming period. It has been observed in the Philippines that *niveosparsus* remains on mango all the year round, breeding in the young leaf-shoots and leaves when there are no flowers available while *clypealis* has many alternate host plants.

Control.—A nicotine-soap spray and a soap solution alone have both been found effective in checking these pests, spraying being started before the flower buds begin to develop and carried on during an attack. Light-traps put out on dark nights are useful for catching the adults especially in places where spraying may not be practicable. In South India,† where the control of these leaf-hoppers is also a serious problem, the application of a resin-fish-oil soap spray is effective at the rate of 1 lb. of the soap to 10 gallons of water. It is not unlikely that, with the development of mango cultivation on an orchard scale in Ceylon, the control of these leaf-hoppers will become a serious problem.

(*To be Continued*)

**Phil. Jl. Sci.* XLVIII, No. 2, pp. 209-235, 1932; L. No. 3, pp. 211-277, 1933.

†Agric. Jl. of India, XXV, No. 1, pp. 17-25, 1930.

THE THIRD INTERNATIONAL CONGRESS OF SOIL SCIENCE, 1935

A. W. R. JOACHIM, Ph.D.,
AGRICULTURAL CHEMIST,
DEPARTMENT OF AGRICULTURE, CEYLON

THE Third International Congress of Soil Science was held at Oxford, England, from the 30th July to the 7th August, 1935, under the presidency of Sir John Russell, Director of the Rothamsted Experiment Station and then President of the International Society of Soil Science. It was attended by over 420 delegates from no less than 57 countries or colonial possessions. The writer was the official representative from Ceylon.

The Congress sessions were divided into the plenary and commission sessions. At each of the former papers relating to matters of fundamental importance in soil science were read by three of the world's foremost soil scientists, after which followed discussions thereon. At the latter, which dealt respectively with the following sections of soil science—soil physics, soil chemistry, soil microbiology, soil fertility, soil genesis, structure and classification, and methods of soil improvement—papers of a more detailed character bearing on the particular Commission's activities were presented and discussed. In addition, there were the opening and closing sessions of the Congress at which matters of a purely business nature were transacted.

During the Congress proper, excursions were made to places or soil areas in the vicinity of interest to soil workers. Rothamsted Experiment Station, Harpenden and the Agricultural Station of Imperial Chemical Industries, Ltd., Bracknell, were thus visited. At the latter the pasture experiments to test the effects of controlled grazing showed most striking results. The adoption of this practice in Ceylon might offer distinct possibilities. The excursions to Bagley wood, Whychwood Forest and the Chiltern Hills were of considerable pedological value,

for they gave the members of the Congress an opportunity of hearing the views of the most distinguished of them on the characteristics of the soil types encountered. Following on the Congress proper, an extensive tour of centres of agricultural importance in Great Britain, was organised for those members who were able to afford the time and cost.

A feature of the Congress was the exhibition of soil monoliths, apparatus, maps, books, etc., held in the Soil Science Institute and the School of Rural Economy of the University of Oxford. This was most instructive, as a fairly representative collection of soils from various parts of the world was available for study and comparison by the largest gathering ever held of the world's soil scientists. To this collection Ceylon had made its contribution.

Arrangements for the accommodation of delegates were as perfect as they could be, some of the Oxford Colleges being available for the purpose. The social side of the Congress was well looked after.

It would take several pages to discuss the scope of the very numerous papers on soil science that were presented to the Congress. These have already been printed in two large volumes of over 620 pages, while a third is in the course of publication. It would suffice to refer to some of the more important of them, so far as they are of interest to Ceylon agriculturists.

In his admirable presidential address on "The Place of Soil Science in Agriculture," Sir John Russell traced the development of modern soil science in the world and outlined the services that it has rendered in the development of the main source of wealth of a country—its soil. The paper by Professor D. J. Hissink of Holland on "Base Exchange in Soils" was a scholarly exposition by one of the pioneers in this field of soil chemistry, which has found practical application in the work of reclamation of the Zuider Zee. Dr. H. G. Thornton's paper on the Symbiotic Relationship between Soil Bacteria and Leguminosae threw important light on a widely—adopted agricultural practice. Professor Mitscherlich's paper summarising the results of a very comprehensive series of tests for the determination of available phosphoric acid and potash in soils, indicated the complexity of the problem and the need for the thorough testing of any rapid method for determining plant food deficiencies

in soils. The field experiment would still appear to offer the most reliable information on the availability of the plant food constituents of a soil. The paper by Waksman and Hutchings on the Function of Cellulose and Lignin in the Preservation of Nitrogen in Soils and Composts was of value in connection with the practice of green manuring and the work on compost-making in Ceylon. The importance of lignin as a preserver of nitrogen was indicated and explained. Professor Fisher's paper on Field Experimentation was one worthy of the originator of the science of modern field experiments. The very interesting contribution by Dr. O. de Vries formerly Director of the Rubber Research Station, Buitenzorg, Java, on "Soil Fertility Studies in the Netherlands Indies," indicated what could be done in agricultural research work if the necessary qualified staff was available. For the eight million hectares (approximately 20 million acres) under cultivation in the Dutch Indies, a staff of 150 fully-qualified academic graduates, with a corresponding number of European and local field assistants, analysts and other helpers is employed. Modern field experimentation has played an important part in the success that has attended agricultural work in these Islands. No less than 3,000–4,000 field experiments (roughly 1 to every 50 hectare) are carried out yearly on sugar-cane alone. Experiments on rice, mainly manurial, count over 1,000 a year. On a less ambitious scale, but nevertheless on a far larger scale than has ever been attempted in Ceylon, field experiments have been carried out with other crops like tobacco, potatoes, etc. Modern soil type mapping, combined with soil analysis on modern lines, is an important feature of work and provides a better basis for the laying out of field experiments and the interpretation of their results, than soil analysis alone. The object lesson to Ceylon is obvious. Systematic field experimentation preceded by soil mapping appears to offer one line of approach to the solution of some of our difficulties in the establishment of a more successful agriculture.

In the field of soil mapping and classification was perhaps the most interest displayed by members of the Congress. Numerous papers were read and discussed on the soils of various countries, tropical soils in particular being the subject of much discussion and comment. In this connection the paper by Professor Hardy of Trinidad on "Some Aspects of Tropical Soils" at a plenary session of the Congress was of absorbing

interest and worthy of close study by students of tropical soils. Of the contributions on tropical soils those of South and East Africa and India were noteworthy. A paper on "Some Important Soil Groups of Ceylon" by the writer threw light on some of the groups of soils found in other tropical countries. A paper which was received with no little interest was that by Dr. W. C. Lowdermilk of the United States Soil Conservation Service on Soil Erosion and its Control in that country. The seriousness of the menace was presented in no exaggerated terms and the measures for its control were briefly outlined. The organisation of a soil conservation service on modest lines would appear to be a need in Ceylon. Ceylon agriculturists should not lose sight of the ever-increasing danger from this source.

Many as were the advantages of attendance at the various sessions of the Conference, it was the personal contact with workers engaged on similar lines of research which was perhaps its most outstanding benefit. It is to be hoped that Ceylon will be represented at all such Conferences in the future. The knowledge and information thereby obtained of soil science and its services to agriculture in the world, and the valuable contacts made cannot but be to the ultimate benefit of the Island. The next International Congress of Soil Science will take place in Germany in 1940.

THE KIDNEY TEA PLANT

ORTHOSIPHON STAMINEUS BENTH

DUNCAN J. DE SOYZA (Dip. Agric., Poona).
AGRICULTURAL INSTRUCTOR, KEGALLA

HISTORY

THE writer happened to come across this species of plant, about two years ago, during his rambles on the study of weed distribution in the vicinity of Rambukkana. It was the profusion of white slender flowers among the rank, green-weed growth that drew his attention.

On examination, three such plants were found, smothered under a blanket of Mikania-weed, within the radius of a yard. They seemed to have grown from cuttings and to all appearance the trio betrayed the fact, that, having escaped cultivation, they had survived severe competition with such weeds that were endemic to the locality. The plants were found growing under the shade of a lately abandoned jak re-afforestation area known as Welikande.

On further investigation, it was found that this plant was first introduced by Messrs August and Julian Hess, two German brothers, who were planting this land with jak in 1928, under a contract from the local Government, but gave up the business about the beginning of 1932. During the re-afforestation of the area, this plant was brought from the wilds of Java and experimented with. Experiments proved successful, the plant genially responded to cultivation and was grown on a field scale. The plantation was closely guarded, and so was the manufacture of its leaf into tea and its export to Germany under the trade mark " HESS". The writer has received information from authentic sources that the Kidney Tea plantation was wholly uprooted and destroyed by fire, before the estate was handed back to Government.

From literature, of which the writer came into possession lately, the following facts were gathered. Although this plant is much reputed for its very potent therapeutic properties in its native home, Western Medical Science had come to know of it, only very recently, and that too by an accident.

Some years ago, a German planter in Batavia who was suffering agonies from a complex kidney disease, pronounced incurable by doctors of Western Medical Science, was entreated by a physician of a native tribe, to try his herbal decoction. The man who had given up all hopes of recovery, submitted to the request, as a last resort and the result was a complete cure.

The decoction was of this particular plant. The grateful patient had this species of plant tested in his home-land and found that it possess excellent properties, which cured such divers complaints as liver disorders, excess of gall, kidney diseases, stone in the bladder and rheumatism. No evil consequences are said to follow its continued usage. It was from this time that this plant came into prominence, being known under several names in Germany, *viz :*— Indischer Niren-U-Blassen-Tee (Indian Kidney and Bladder Tea), Indischer Leber-U-Gallen-Tee (Indian Liver and Gall Tea).

It is known in this part of the country as Kidney Tea, German tea and medicinal tea. Owing to its medicinal value and commercial importance, this plant is now cultivated in large plantations in Sumatra and Java. An estate that grows this tea on an extensive scale is the " Medicinal-Tee Plantage," Tandjong Moelia, Sumatra. All the prepared tea from this plantation, goes to Germany, where the active principles are extracted and used in the manufacture of patent medicines for specific diseases mentioned elsewhere. Little is known in this country about the unique medicinal properties of this plant or the commercial possibilities its cultivation would afford to the enterprising planter.

DESCRIPTION

This plant is a native of the East, being commonly met with in Assam, Burma, Sumatra, Java, Borneo, Philippine Islands and even as far as North-east Australia. It belongs to the Natural Order Labiatae, a widely distributed family of plants, most of whose members have characteristic aromatic properties, due to the presence of glandular hairs, secreting volatile oils.

It is allied to such flavouring herbs as *Mentha* (Eng. Mint, Sin. Minchi); flowering plants as *Salvia* and *Coleus;* fragrant oil-bearing plants as *Lavendula* (Eng. Lavender); *Ocimum* (Eng. Basil, Sin. Maduru-tala); and edible tuberous plants or medicinal herbs as Plectranthus (Sin. Innala and Iriweriya).

The kidney tea is an erect or decumbent, somewhat woody perennial herb growing to about two feet in height ; sparingly branched at base, tetragonous, pubescent or glabrous, the more

herbaceous parts being tinged greenish violet on one or more sides and very shallowly ribbed.

Leaves.—One to four inches long, exstipulate, decussate, rather distantly placed, narrowly or broadly lanceolate, usually deeply and irregularly serrate, crenate, lubolate or entire, dark-green above and paler beneath.

Inflorescence.—A profusely flowered, simple, slender, erect, terminal, narrowly pyramidal raceme, 5 to 10 inches long. Flowers six or under, arranged in whorls ; each whorl consisting of two sets of three flowers each, the sets being placed opposite and decussate, on a 4-gonous peduncle, with a tiny, rigid, ovate bract to each set ; pedicels slender, about a $\frac{1}{4}$ inch long.

Calyx.—Tube about $\frac{1}{2}$ cm. long, base rounded ; upper lip, orbicular, erect and slightly recurved ; lower lip with two long, subuliform middle teeth and two short, broad, mucronate lateral ones, auricled towards the upper lip.

Corolla.—Bilabiate, ringent ; apparently white, but on closer examination, reveals a varying tint of very faint blue lilac ; tube straight, slender, about $\frac{1}{2}$ inch long ; lip is long as tube ; lower, narrowly oblong, concave, horizontal ; upper equally long, broad, recurved, tri-lobed at top, mid-lobe notched.

Stamens.—Four, epipetalous ; filaments, 1 to $1\frac{1}{2}$ inches long, bluish white below, pale lilac, assuming deeper hue on nearing anthers ; anthers, innate, very small and dark.

Style.—Always slightly longer than stamens and coloured as filaments ; stigma, deep lilac, oblong, with two minute lips.

Fruit.—A carcerulus, consisting of 1 to 4 oblong, tuberculate, nutlets, borne on a recurved, tumid disk ; fruits invariably fall off before maturity.

Cultivation.—The plant is quite at home in both mid and low elevations. Although it thrives best under thin shade, it grows satisfactorily under open conditions, flourishing luxuriantly in rich and rather moist soil. It is adaptable to a wide range of climate and soils, and stands dry conditions remarkably. Stiff clay, which tends to bake and crack in dry weather, is not suitable for this plant, and when such conditions persist, it begins to languish rapidly, unless mulching is resorted to. Propagation is done by cuttings, of about 6 inches in length ; mature stems with a couple of nodes should be selected. On a field scale, planting is best done in triple rows, $1\frac{1}{2}$ ft. apart with $1\frac{1}{2}$ ft. in the row, and 2 space of 3 ft. between the triple rows. Cuttings may be raised in nurseries and transplanted, or they may be stuck slantwise, right out in the field and heeled

in during monsoon weather, when they will strike root easily. Once the crop is established, very little after care is necessary, except for the maintenance of a surface mulch throughout the three-foot space between the triple rows. On either side of this space, running along the length of the row, the soil should be well forked in once a year at the commencement of the monsoons, preferably with a nitrogenous fertiliser or with an organic manure. In soils poor in humus, it is essential to grow a quick-growing leguminous shrub, which will supply the necessary green material for mulching or forking in.

Gliricidia maculata (Sin. Weta-hira) will serve the purpose. The bushes should be given a light pruning every two years. Catch crops such as kapok or papaw for the sake of fruits or for extraction of papain, can be grown to advantage. As a catch crop in coconut or rubber, the cultivation of this plant should prove remunerative.

PESTS AND DISEASES

Scale insects have been noticed to occur among Kidney Tea, while chlorosis in leaves, perhaps due to deficiency of iron in the soil, is often met with.

PLUCKING, CURING, ETC.

Although an appreciable flush appears within two months from time of planting, it is best for the health of the plants, to delay the first plucking for a month or more, removing any flower-heads that may appear in the meanwhile.

The method of plucking the leaves is just the same as that employed with common tea, the tender bud and shoot with 2 to 4 leaves, being nipped off by hand. Pluckings can be made at intervals of 2 to 3 weeks. Flower-heads should not be encouraged, but nipped off.

The curing process is very simple, in that the leaves are withered for about 24 hours on tiers of jute hessian frames in well ventilated rooms. After withering, the leaves are spread out thinly to dry in the sun on collapsible hessian frames, measuring 3 ft. by 9 ft. and standing about 2 ft. off the ground. During wet weather, withering can be hastened by driving hot air through the withering sheds and drying done in hot air chambers or barns. Such chambers may be constructed on the same principle as employed in papain-curing ovens or tobacco flue-curing barns. Whichever method is employed, curing should not be hastened, as this tends to scorch the leaves, thereby removing the efficiency of the active principles present in the leaf cells. In the fire process, the withered leaves should be spread on cloth frames and fed to the curing chambers.

The temperature should be round about 100 F. When the leaves are crisp-dry, they are removed straightaway from the curing frames, on to a wire sieve with 3 mm. square meshes. The leaves are immediately sifted through this by a crushing and kneading process, done with the aid of hands or with groved wooden rollers. The finished product, before damping, is stored away in air-tight tins or packed in lead-lined tea chests, ready for export ; 6 lb. of green leaf give about 1 lb. of cured tea.

Most of the Kidney Tea grown on the estates of Sumatra is exported to Germany. The buyers prefer sun-dried tea to the oven-cured product, as it is believed that high temperatures destroy the medicinal properties of the leaf.

As a very potent remedy for rheumatism and other afflictions of the liver, kidneys and bladder, half a tea-spoonful of this tea, infused in a cup of hot water, strained, with sugar to taste and drunk once or twice a day is all that is needed. The prepared tea tastes very much like " *Ranawara-tea* " (Tea prepared from dried flowers of *Cassia auriculata*). Here is a plant thats worth the patronage of the College of Indigenous Medicine. Apart from its therapeutic value, this humble herb is a beautiful and free bloomer and deserves a corner in every home garden.

Note.—The botanical description of the plant is as laid down by Bentham, though the writer has gone into useful detail, especially with regard to the inflorescence. The history of the plant was taken from a leaflet in German, advertising this tea, by Indischer Medizinal-Tee-Import, August Hess, Stadtroda, im Thüringen. Useful information as regards the introduction of this plant to Ceylon, its cultivation and manufacture of tea, etc., was given to the writer by K. Albert Silva, who was employed on Welikanda Estate. The writer is greatly indebted to Dr. J. C. Haigh, Economic Botanist, Department of Agriculture, Ceylon, for the identification of the plant.

ANGRAECUM EBURNEUM THOUARS

NOTES ON ORCHIDS CULTIVATED IN CEYLON

ANGRAECUM EBURNEUM THOUARS

K. J. ALEX. SYLVA, F.R.H.S.
SUPERINTENDENT OF PARKS, COLOMBO

THE genus Angraecum includes a remarkable and curious group of epiphytal orchids of variable habit and character confined to Tropical Africa and its Islands.

There are about 120 species of the genus and about one half of this number is indigenous to Madagascar. The genus is not only remarkable for large flowering species, but also for others which consist of leafless plants. The latter cling to the branches of trees by flat bands resembling roots, their flowers being so small and unattractive as to merit attention only as botanical specimens.

Angraecum eburneum Thouars is a native of Seychelles, Bourbon and Madagascar. It has a robust growing habit and flowers freely.

The green fleshy and leathery leaves are arranged in two rows on a short, densely packed stem and are about twelve to eighteen inches long by about three inches broad. The apex of the leaf is obliquely bifid and the whole leaf is unequally divided by a fleshy mid-rib.

The erect raceme often reaching two feet or more is loosely flowered, clothed with numerous large, distantly placed sheathing scales. Flowers are about two and a half inches across with a green tube-like spur extending about six inches downwards. The sepals and petals are almost of equal size, about one and a half inches long and about quarter inch broad, and of a greenish colour. The broad labellum is pure white with a pointed tooth at its base. The petiole of the flower is twisted, grooved and six-ridged.

Culture.—Angraecum eburneum, being a strong-growing plant and often reaching three feet or more in height, should best be grown in large, perforated pots or wooden tubs. The bottom half of the pot should be filled purely with drainage material and the remaining half with a compost made up of bits of charcoal, brick, chips of hardwood or old husk. As the plant advances in growth and new roots appear emerging from the stem above the pot, fresh compost may be placed on the surface of the pot to induce these roots to set.

A well-grown specimen resents any disturbance at the roots save light periodical top-dressing after picking away the old compost.

Propagation can be easily effected by severing basal or stem suckers when sufficiently established on the mother plant. These should first be established in smaller pots and gradually transplanted into bigger ones as becomes necessary.

As a rule all Angraecums require warm, moist atmospheric conditions and resent crowding. They can easily be grown in the open by gradual hardening to this situation. Moisture should be given freely at the roots both during the growing season and in dry months.

DEPARTMENTAL NOTES

ADLAY

H. A. PIERIS, B.A. (Cantab.), A.I.C.T.A. (Trinidad),
DIVISIONAL AGRICULTURAL OFFICER, CENTRAL

HISTORY

ADLAY (*Coix Lachryma-jobi*), or Job's Tears, commonly known as barley, is not unlike the latter in appearance hence the misnomer. This edible grain is of historical importance since it was cultivated in India about 3000 or 4000 years ago. It was known to the ancient Arabs who introduced it to the West. It was also grown in ancient times in China, Japan, and other tropical countries. In old records mention has been made of the plant only as a weed or cultivated as an ornamental plant. Early writers refer to the use of seed as beads for rosaries. An early missionary writer of Tonkin has said that adlay makes a refreshing drink, is a good blood purifier and an excellent diuretic. People in Tonkin call it the "Grass of Life". It is said that in India, Coix can hardly be said to enjoy a reputation for its medicinal properties. The grain was never too popular on this continent in view of the varied assortment of other cereals, but in times of scarcity Coix has been cultivated extensively as a food crop.

TYPES

There are many wild and cultivated forms of adlay. The wild species can be distinguished from the edible forms as the shell of the former is tough and the grain is hard. The edible varieties have a thin shell and are soft grained.

CULTIVATION

Adlay can be grown in chenas as a mixed crop, or as a pure crop in home gardens or in abandoned owita land where drainage is good. It will not thrive under water-logged conditions. It is most suited to friable or loamy soils with an abundant supply of humus, but seldom does well on heavy clay soils. It grows admirably from sea level up to elevations of about 2000 feet.

Adlay has been tried in different villages in Kegalle, Nawalapitiya, Dambulla and in Kandy district, and has given excellent results. The rainfall during its growing period should be evenly distributed. Dry weather should prevail when ear-heads begin to mature. In very dry districts it is necessary to irrigate the crop. Adlay tillers profusely when grown on well cultivated soil. The land is usually ploughed and harrowed or mamoty-forked.

On an even seed-bed 3 or 4 seeds are dibbled in by hand $2\frac{1}{2}$ ft. by $2\frac{1}{2}$ ft. apart and in rows. If the seed is not very fresh the seed rate may be doubled. For normal sowing 6 to 8 lb. will be required. When plants are about 3 ins. high, they are thinned leaving a couple in each hole. Plants are earthed up when 6 ins. to 8 ins. high. Inter-cultivation excepting periodic weeding is not necessary. The crop is ready to harvest in 5 to 6 months from sowing. A dressing of farmyard manure when the seed-bed is prepared is beneficial, especially in soil deficient in humus, but an excessive supply is not advisable as it would tend to promote vegetative growth at the expense of grain production. A few months after the harvesting of the crop the plants will tiller again and a ratoon crop can be reaped. Harvesting is done on a fine day preferably in the morning. Stalks are cut about 6 ins. from the ground. They are spread out in bundles and when thoroughly dry, threshed in the same way as other grains. Milling is done with an indigenous wooden mortar or in a stone corn-crusher. The former method is preferable. Grains should be absolutely dry before milling, otherwise a considerable proportion will be crushed. The yield per acre on average land is about 75 bushels of grain which produces about 25 bushels of cleaned grain.

USES

Coix is an excellent substitute for rice and is more nourishing. It can be boiled whole or partly broken. The flour is an admirable substitute for rice flour for the preparation of articles of food such as hoppers, milk rice and roti, which are usually indispensible as a morning meal among the indigenous population. The offals or millings can be utilised as food for poultry and farm animals. Tender adlay plants can be used as fodder for cattle. Plants before they are mature could also be used for preparation of silage for cattle. Unfortunately the grain has not earned the popularity it should considering the varied uses to which it can be put. This may be attributed to the ignorance of growers. Moorish cultivators have displayed

keen interest in the cultivation of this crop. There are possibilities of popularising this crop in small holdings and peasant proprietor settlements in many parts of the island. Taking the average consumption of rice per head per day as 5/8 of a measure, a crop of adlay from an acre of land will provide sufficient food for a family of four people for about a year.

Wester in his article on adlay states that this grain has a greater proportion of fat and protein content than either rice or wheat and as such it is a more complete food than either of these grains.

ANALYSES OF ADLAY—RICE—WHEAT

	Water	*Protein*	*Fat*	*Carbo-hydrates*	*Fibre*	*Ash*
(*a*) Adlay (*Coix Lachryma-jobi*) (threshed)	10·8	17·6	5·6	62·1	0·3	3·6
(*b*) Raw Rice (*Oryza sativa*) (Polished)	12·21	7·64	1·00	77·9	0·33	1·0
(*c*) Wheat	10·62	12·23	1·75	71·18	2·36	1·81

Acknowledgment is due to Dr. A. W. R. Joachim for the above analyses.

REFERENCES

WATT, SIR G.—The Commercial Products of India.

WESTER, P. J.—Adlay—A new Grain. *Philippine Farmer*, VII, No. 3. Reproduced in *Trop. Agriculturist*. LVII, No. 1, pp. 43-46, 1921.

THE IMPERIAL INSTITUTE AND THE COLONIES*

FURTHER progress in investigational and intelligence work on Empire products is described in the annual report for 1935 of the Director of the Imperial Institute. A noticeable feature of this account is the prominence given to developments affecting the Colonial Empire, chief among which was the establishment by the Colonial Office of the Colonial Forest Resources Development Department and its location at the Institute. This arrangement has already been of much mutual benefit.

The main work of the Committee on Timbers during the year under review was in connection with the Report on Grading Rules and Standard Sizes for Empire Hardwoods. Suggested amendments from Nigeria and British Honduras, among others, are being considered. It was proposed to send to the United Kingdom a trial shipment of selected Nigerian timbers, graded according to the Rules, in order to provide a practical test of their applicability. Additions to the list of Colonial hardwoods approved by the London County Council's committee as fire-resisting materials include Sekondi Mahogany from the Gold Coast and Red Meranti from Malaya.

Besides recording the decision of the Admiralty in favour of tarred sisal cordage, the Committee on Vegetable Fibres report arrangements for an Exhibition of Empire Vegetable Fibres at the Institute in the spring of 1936, at which will be included, among the principal exhibits, sisal from East Africa, hemp from Mauritius, and coir from Ceylon. This Committee arranged for Institute co-operation in the research into the possibilities of further commercial utilisation of sisal, to be carried out at the laboratories of the Linen Industry Research Association.

Work on the problems involve in the production of tung oil from the fruits was continued by the Committee on Oils and Oilseeds, which is also endeavouring to make arrangements for crushing in the United Kingdom the produce of a number of small growers.

The Committee on Hides and Skins investigated the results of six different methods of curing hides, and found that only those hides prepared by the dry-salting or shade-drying methods, or by the modified sun-drying method recommended by the committee to the authorities in Kenya, could be considered satisfactory. The market possibilities of prime camel hides from Somaliland were studied, and small consignments tested gave promising results. Faults in finished leather are being correlated with specific diseases in the living animal.

PRODUCTS INVESTIGATED

The Investigations Section of the Plant and Animal Products Department was engaged on a wide variety of chemical and technical examinations, and furnished reports on 402 samples received chiefly from Agricultural

*From *The Crown Colonist*, March, 1936.

and Forestry Departments overseas. Piassava from inland swamps in Sierra Leone submitted to the trade was considered to be worth a price well above that of Sulima piassava. *Abroma augusta* fibre from Uganda was pronounced by merchants to be about equal in quality to First Marks jute, and its suitability as a substitute is to be investigated. A sample of groundnut oil from the Sudan was regarded as a saleable in the United Kingdom at about the current price. An investigation into *Cymbopogon afronardus* oil from Kenya showed that it might be used as a source of geraniol. Inquiries in the trade indicated that consignments of peppermint oil from Kenya would be marketable at a price between those of American and English peppermint oils. Three out of seven samples of geranium oil from St. Helena were found to be of possible commercial interest. Derris root from the Amani Institute, Tanganyika, yielded materials of excellent quality, which should be readily saleable in the United Kingdom. Papain prepared in the Bahr-el-Ghazal Province of the Sudan was considered to be of slightly higher quality than Ceylon papain. Mangrove bark from Tanganyika represented material which would meet the requirements of the United Kingdom and Continental markets for a "non-fibrous" bark, and both this and the "fibrous" bark could be disposed of in the United States. To suppliers of native-grown tobacco leaf in Jamaica it was suggested that, as the leaves were not large enough for use as binders by English cigar manufacturers, they should be supplied for use as fillers in the cheaper brands of cigars. The Department of Agriculture in Fiji was advised to concentrate the attention of tobacco growers on the production of cigar leaf only. A sample of beeswax from the Gambia was regarded as being quite suitable for the United Kingdom market. Other investigations related to banana flour from the Gold Coast, foodstuffs from Ceylon, ginger from British Honduras, castor seed from Ceylon, resin from the Solomon Islands, and gums from Northern Rhodesia and Tanganyika.

MANUFACTURING AND MARKETING

Over a thousand inquiries were dealt with by the Intelligence Section, those from Colonies relating, among other matters, to the possibility of manufacturing coir products in Ceylon, the commercial production of sultanas and currants in Cyprus, improving the trade in Malayan tortoiseshell, large-scale planting of pyrethrum in Palestine, industrial developments in Fiji and fruit canning, in Ceylon, many of these inquiries being concerned with opportunities for marketing supplies in the United Kingdom.

Some inquirers sought information regarding machinery for preparing commodities for the market ; others, usually manufacturers of machinery, required data concerning products not previously handled by them, such as "Kekuna" seed (candle nuts) from Ceylon. Information supplied also related to Empire sources of supply of products normally obtained from foreign countries, among such applications being one for chicle gum ; British Honduras was named. The miscellaneous inquiries included the following : the preparation of ghee in Nigeria, the commercial utilisation of soya beans and oil, cultivation of the tonca bean tree in British Guiana and the preparation and marketing of the beans, the possibilities of an export trade in beeswax from Northern Rhodesia, the preparation of jute from the Sudan,

the possibilities of seaweed as manure in Zanzibar, and the method of preparing, drying and marketing rattans from Sarawak.

Numerous investigations on behalf of Colonial territories were made by the Mineral Resources Department of the Institute, the subjects ranging from Solomon Islands and East African soils to manures from Malta. Nigeria sent two samples of topaz, ilmenite came from Nyasaland, saline marls and muds from the Bahamas, coconut shell charcoal from British North Borneo, sand and pebbles from the Falkland Islands, peat from Palestine, lignite from the Cameroons, graphite rocks from Tanganyika, cinnamon-leaf compost from the Seychelles, and salt from Bechuanaland. On the Intelligence side, inquiries dealt with concerned Falkland Islands peat, pottery clays (for Kenya), prospecting in British Guiana, aluminium manufacture in Nyasaland, sources of columbite in Nigeria, Uganda and South-West Africa, Fijian coral for building purposes and cement, beryllium mineral production in East Africa, cobalt in Northern Rhodesia, zircon in Malaya, and many other subjects. In addition, the possibility of marketing gypsum from East Africa received attention, as did the following inquiries : guano on Ascension Island, market for marbles from Trans-Jordan, lignite in Trinidad, market for platiniferous ilmenite from Sierra Leone, Seychelles phosphate, and a market for Sudan natron.

COLONIAL COURTS

In the exhibition galleries of the Institute more vivid impressions of Empire countries are now being conveyed by representing as complete a picture as possible of the scenery, and arranging the exhibits in such a way as to give the visitor the effect of a journey through the country. Malta now has a new court, and the Palestine court is being completely reorganised and enlarged. Bermuda and Seychelles also have added to the attractions of their respective courts. Further, the chief economic products of each Dominion and Colony are displayed, and, where possible, their various applications illustrated by specimen articles.

For the first time the Report contains a complete record of officers of the Colonial Services visiting the Institute during the year, the number of such visitors being 100.

SOME ASPECTS OF THE POULTRY INDUSTRY IN KENYA*

THE prevailing low prices for produce have emphasized the desirability of converting them in part into other products before they leave the farm. For this reason, a number of farmers are turning to poultry as a side-line to their other activities. It is probably as a side-line only that the enterprise will prove reasonably profitable, so that the fullest utilization of surplus produce can be made. As a proposition by itself, where all foods have to be bought and transported, there is probably not very much scope in Kenya ; for, apart from the difficulties that arise where large numbers are handled, the outlet for poultry products is not at the present time sufficiently great to justify a large expansion on these lines.

While there is a fairly steady demand for eggs, yet the marketing of surplus cockerels and old hens (particularly the latter) is, in up-country districts particularly, a very difficult problem, although in the vicinity of towns there may be a small demand. Therefore the policy should be as far as possible one of egg-production, and the elimination of surplus cockerels at the earliest possible stage should be practised. For this reason, the desirability of sexing day-old birds, a practice which is now adopted on a very large scale in Europe, would be extremely useful in this country. It should be pointed out, however, that the determination of sex by this method is by no means easy, and it requires a great deal of practice before an approach to accurate results can be obtained. The alternatives to the above method are use of sex-linked crosses, or alternatively of light breeds in which the cockerels can be distinguished at about three weeks of age. Although this last method entails the expense of rearing a large number of redundant males to the age of three weeks, yet it is probably the most practicable method at the present stage, for the use of sex-linked crosses involves the maintenance of two separate flocks of pure-bred birds to be used for crossing purposes, and this necessarily entails the rearing of a fair number of pure-bred stock to provide material for the selection of breeding birds.

The choice of breeds, as outlined above, is largely influenced by the presence or absence of a market for meat, and will lie therefore in most cases with the light breeds. Apart from these considerations, it is important to remember that it is desirable to choose a breed which is already well represented in the country, so that there will be a sufficient number of strains to prevent the possibility of inbreeding, a danger in a country where it is of most vital

*By R. S. Ball, Dip. Agric. (Cantab.), A.I.C.T.A., Agricultural Officer, Kenya Colony, in *The East African Agricultural Journal of Kenya, Tanganyika, Uganda and Zanzibar*, **Vol. I, No. 4, January, 1936.**

importance to maintain the constitution of the stock. There is always a tendency to degeneration of progeny of imported stock, this being noticed particularly in size and weight and composition of the bone. In the opinion of the writer, however, these difficulties can in large measure be overcome by rigorous selection of breeding stock and careful feeding of suitable rations and mixtures containing the necessary mineral ingredients.

It is of great importance to adopt a definite policy and to continue with it, for the introduction of a large number of breeds and indiscriminate mixing leads eventually to the segregation of many bad types, and does not, as is sometimes supposed, improve the constitution of the stock.

PROBLEMS OF HOUSING

As a rule, housing is not a difficult problem in this country, except in so far as it entails strict attention to cleanliness and protection from vermin of all sorts. A very important factor to bear in mind is that poultry always thrive best in small units, an economic unit being about 30 birds.

For this reason the Hosier system of portable housing units, each unit comprising about 20-30 birds, has much to recommend it, but it has also three grave disadvantages—

(1) It is not suited for heavy breeds, as they do not get enough exercise, and tend to get too fat.

(2) It is absolutely essential to ensure that adequate provision is made for shading the units, as the birds will never thrive if exposed all day in the sun in one of these units without adequate protection.

(3) The grass on which the birds are folded should be short. Folding on tall herbage of the red-oat grass type leads to chills and scouring through the birds running about in the long grass when it is wet with dew or rain, and further they are liable to suffer from impaction of the crop through eating coarse and fibrous material.

Apart from these two latter pitfalls, and the fact that it is probably suited only to light breeds in this country, it combines all the advantages of keeping birds in small numbers, protection from vermin, since the unit is completely enclosed (house and run being made as one), and the provision of fresh unstained land for the flock.

If, however, the difficulties enumerated above cannot be overcome, or heavy breeds are kept, some form of permanent house and run must be used, but in this case it is most important to ensure that adequate provision is made for resting the runs, so that a grass cover can be maintained, the most obvious method being to divide the run into two so that it can be served by the one house. With regard to the house itself, this can be of very varied design, and many excellent types are to be seen in the country. A wire-netting floor (of small mesh, about 1 in.) is highly desirable, so that the droppings may fall through, either into a platform underneath, which can be moved and cleaned, or, if the house itself is movable, they may fall through to the ground and the whole house be put on a fresh site when the ground has become stained. Obviously houses of this type must be raised off the

ground, and it is in fact always desirable that this should be done so as to provide a free circulation of air underneath. Birds should not be allowed to roost on the wire netting, but should always have perch space provided, for which it is better to use properly cut and planed timber than rough branches which are not so comfortable to the birds' feet. Nest-boxes should always be as dark as possible, so as to lessen the risk of birds eating the eggs, and if possible should have a front which can be shut down at night, and prevent birds roosting in them. Obviously the type of house mentioned above is most suited for small units, but where units of 100 birds or so have to be housed a more permanent type of building with wooden floor is required. There are diverse views with regard to the roofing of poultry houses, as to whether corrugated iron or grass should be used. While grass undoubtedly keeps the house cooler, yet it is absolutely essential that it should be removed completely and burnt periodically and the roof re-thatched so as to prevent vermin from being harboured in it. The same remark applies to the use of scratching sheds where the birds are provided with straw in which their corn is scattered. Unless these are thoroughly cleaned out and the straw burnt at frequent intervals, it is probably best to dispense with them altogether.

There is one fault closely connected with housing that is liable to occur, and that is the indiscriminate mixing of birds of different ages. This is in some cases due to the collapsing of partitions between runs, etc., which facilitates mixing, but also the fact that the harm done by such a practice is not always realized. Apart from the fact that the distribution of food is likely to be uneven, there is always a tendency when the older birds cease to lay and start to moult for younger stock to go into a neck-moult, which will either delay them from coming into lay or will put them off if they have already commenced. For this reason flocks should always be segregated as far as possible into : pullets not yet laying ; pullets six months to one year ; birds over one year ; over one and a half to under two years ; and birds two years and over. This will not usually involve any additional housing, but will yield much more satisfactory results. The fact that there is no definite hatching season in this country has probably been one of the chief factors contributing to this mixing of ages, for it entails a continuous supply of birds of all ages, and thus segregation becomes difficult, but provided the birds are divided into the categories described above results should be quite satisfactory.

FEEDING

The feeding of the birds will, to a large extent, depend on the foods that can be grown on the farm, and in most districts this provides a fairly extensive variety, but at all times it is necessary to supplement with certain purchased foods such as wheat offals, etc. As a general rule, maize bulks large in the ration fed to the birds, its chief recommendation being its cheapness. It is important to realize that many of the cases of digestive orders that occur (excessive scouring, liver troubles, etc.) are probably due in large measure to the use of maize in excessive quantities either in the mash or corn mixture. The relatively high price of chick wheat in relation to maize has deterred farmers from using it in sufficient quantities, with often very unsatisfactory results. It should be remembered that there are other foods in addition to

maize and wheat, such as buckwheat, barley and sunflower, all of which can be used in a certain proportion in the corn ration, and which can be grown cheaply on the farm. It is unwise, however, to make any of these the basis of one's corn ration, which should always, as far as possible, be wheat, with these other grains in smaller quantities.

Finally, it is important to note that it is always preferable to feed good wheat in preference to droughted or pinched grain.

Examples of such rations are as follows:

(1)
2 parts Wheat
1 part Crushed Maize
1 part Sunflower.

(2)
3 parts Wheat
2 parts Crushed Maize
1 part Buckwheat.

(3)
3 parts Wheat
1 part Barley
2 parts Crushed Maize
1 part Sunflower
1 part Buckwheat.

Maize should be fed kibbled, and sunflower slightly bruised so as to break the outer husk. If one kind of grain is fed by itself, then wheat is the most suitable, the remainder being most suited to mixtures on the lines outlined above. A bird in full lay should receive 1½ oz. of grain per day, preferably in two feeds—early morning and evening.

There is a considerable divergence of opinion as to the desirability or otherwise of feeding dry mash as opposed to wet mash. In this connection it is important to remember that one of the chief advantages of dry mash feeding is economy of labour, an important consideration in Europe but relatively less so in this country. Unless carefully controlled, there is always the danger with the dry mash system that the birds will be eating an unbalanced ration, since they are able to pick the food over at will, so that its composition tends to alter and this may cause digestive disturbances. Further, since skim milk is frequently available in this country, which may be utilized for mixing with the mash, the case for wet mash feeding is further strengthened.

While the majority of the corn rations can usually be produced on the farm, yet it is essential to purchase certain feeding stuffs for the mash portion. These are chiefly pollard, bran and meat meal. With reference to the latter, it is probable that this can be replaced at least partially by the use of vegetable protein, *e.g.*, Soya beans, together with a mineral supplement. In this latter connection it is important to remember that nearly all the foods fed are themselves deficient in minerals, and it is therefore of great importance to add a complete mineral supplement to the ration. In this way growing birds will be enabled to form hard bone, the crooked breast-bones which are

of fairly frequent occurrence being probably due to soft bone which has easily become bent will be eliminated; and further the minimum number of soft shelled eggs will be laid. It is worth stating, however, in this latter connection that there are always a few birds in the flock which will lay soft shelled eggs, however adequate the mineral supplement in their ration may be, this being due either to hereditary taint or some constitutional defect. Such birds should not, of course, be selected for breeding.

The chief minerals of importance and those most likely to be deficient are as follows: lime, phosphate, salt, iron (sometimes). These are most readily added in the ration in the form of ground limestone, steamed bone flour or meat and bone meal, salt finely ground, and iron oxide if necessary. The last is usually only required for young brooder and rearing chicks in cases where there is a lack of iron in the soil. Salt should always be finely ground, as it is toxic in large quantities, and should for this reason not be in a lumpy state when fed. The total mineral constituents should constitute about two per cent. of the ration. If meat and bone meal is being fed, no steamed bone flour is necessary.

The proportions of the minerals should be roughly as follows:

Salt	½ per cent.
Ground Limestone	1 per cent.
Steamed Bone Flour	½ per cent.

When iron oxide is being fed to young stock, only about ¼ per cent. need be included.

A suitable laying mash where skim milk is available would be as follows:—

45 parts Pollard
15 parts Bran
30 parts Maize Meal
5 parts Soya Bean (or other vegetable protein)
3 parts Meat and Bone Meal
2 parts Minerals.

100

Without Skim Milk.

45 parts Pollard
13 parts Bran
25 parts Maize Meal
10 parts Soya Bean Meal
5 parts Meat and Bone Meal
2 parts Minerals.

100

The feeding of greenstuff of course is always highly desirable, and this should consist largely of kale, cabbages, etc. Poultry are as a rule not very fond of lucerne when fed long, owing to the large amount of stem present in relation to leaf. For this reason, if it is desired to feed lucerne, it is best to

grind it up finely and incorporate it in the mash. The stemmy material is all reduced by the grinding, rendering it more palatable to the birds. In this manner it has a high feeding value, for it is rich in protein, and is of course largely used in Europe and America in the dried powdered form as Alfalfa meal, to replace some of the protein in the mash.

In addition to the provision of oyster shell for the birds, it is essential to provide some sharp grit in the mixture with it, if the soil does not already contain a sufficient quantity. It is essential that the grit should be sharp, as it is required to perform the grinding action in the gizzard which is necessary for efficient digestion. Often it is possible to find some rock or stone locally which, when broken up with a hammer, will serve the purpose.

The system of feeding outlined above is naturally somewhat expensive, but amply justified in pullets and second-year birds in full lay. Frequently, owing to lack of market, it is impossible to dispose of old birds when their period of maximum usefulness has passed, and yet they will probably continue to lay a few eggs, but not in sufficient quantity to justify elaborate or expensive feeding. Such birds are probably best ranched out in portable houses, risking vermin damage and allowing them free range. In this manner, together with a cheap corn ration consisting largely of maize, and possibly a little mash if the birds are in poor condition, although even this may be unnecessary, eggs will be obtained with the minimum expenditure, until such time as the birds cease to yield a return or preferably until a market can be found for them. It is extremely important to cut expenditure to the minimum on such stock, for the return will not be high, and output is not likely to be affected appreciably by very cheap feeding, since quality of food has ceased to be the limiting factor in the birds' capacity to produce eggs. This feature again emphasizes the great importance of segregating birds into age groups.

CULLING

In every flock there are certain to be a percentage of birds which do not yield a sufficient return to justify the feeding, and these again might in some cases be treated in the manner suggested for old hens, if they cannot be disposed of in any other way. These birds are of two types, and are best discussed separately.

(1) *Wasters.*—These are birds which never put on flesh, but are always in a thin and unhealthy condition. They are chiefly found amongst the light breeds, where there has been a tendency to breed for egg production, sometimes at the expense of constitution. These birds are never likely to be of any use even to run with a "cull flock" and should be destroyed. They are always easy to detect by their poor condition and lack of comb and wattle development, or bad coloration of these organs.

(2) The other class consists of birds which are healthy in appearance, but either genetically or constitutionally are incapable of high egg production. These can only be culled out by frequent and careful handling of the flock. They usually tend to be loose-feathered birds, with a marked tendency in the case of the heavy breeds to lay on large quantities of yellow fat internally. The heads and combs are usually coarse and thick, and frequently

the feathering in the heavy breeds is carried right forward over the head, the feathers being of a coarse and bristle-like nature. The distance between the pelvic bones is narrow and the points of the bones are large and feel definitely knobby as opposed to the finer points as found in a good layer. The region below the pelvic bones is usually lacking in capacity, with a tendency to a rather hard and tight skin. The scales on the legs, instead of being set on tightly, are frequently loose and of rather an open nature. A common feature of an unsatisfactory bird is the length of claw, but this criterion should not be applied in this country, where many of the soils are deficient in gritty material, with the result that the amount of wear and tear on the claws is necessarily very small.

For these reasons, great attention must be paid to the proper handling and culling of all laying stock, and, unless the birds are trap nested, selection of breeding stock will depend on this handling also.

SELECTION AND HANDLING OF BREEDING STOCK

If trap-nesting has been practised, the selection of breeding stock is rendered relatively simple, for the records of a large number of birds are then obtainable, and selection amongst the best of these is made on characters such as size, constitution, thriftiness, character of bone and breed points. As it is often difficult to trap-nest, owing to lack of suitable labour and facilities, in the majority of cases breeding stock must be selected by careful handling on the lines previously indicated. Where a flock has been culled regularly this should prove a relatively simple matter, as the farmer will by then have acquired a sound knowledge of the technique of the handling of birds. If possible, no female stock should be used for breeding until they have reached the age of at least 12 months. By attention to this feature, the minimum number of weakly chicks will be obtained. In the case of the heavy breeds, 15 months is an ideal age for the selection of breeding stock. The male bird of a light breed can be used at an age of about 8 months, and in the case of a heavy breed 10 months, by which time he will have grown well. The use of birds at earlier ages than this definitely retards growth, and as it has been suggested may affect the constitution of the offspring. At the other end of the scale, it is very common to observe a decrease in the fertility of the eggs after the breeding stock have reached an age of about 2¼ years, depending on the breed. In most cases this is due to the male bird, and the number of females should then be reduced. Initially, in the case of a light breed, about 12 females should be allowed to one male bird, although 15 can be used, provided he is well grown and at an optimum age of about 1½ years. In the case of the heavy breeds the number of 10 females should not be exceeded.

It is frequently advisable also to select a small pen of 6 to 8 really first class birds for purposes of cockerel breeding, and these are mated with an unrelated purchased male. In this manner a sufficient number of male birds are obtained for mating with the rest of the breeding stock, without incurring the expense of the purchase of a large number of unrelated males. It is of great advantage to trap-nest such a pen, as any surplus cockerels can then be sold with a definite record behind them, which will naturally enable a

higher price to be obtained. Such individually bred birds can be hatched out in the incubator in the normal way, by placing all the eggs from one of these six birds together in a small cage after about the eighteenth day, so that all the chicks from one hen can be toe-punched at birth or marked with a numbered ring affixed to the wing or leg before they have had the opportunity to get mixed with the rest of the hatch, with which they may be reared in the normal way.

In the ordinary breeding flock it is often desirable to run two male birds together with rather over double the number of females that would normally be allotted to a single male, as this usually leads to a higher fertility in the eggs. The chief objection to this system is that two male birds are often liable to fight together, but the risk of this is usually much lessened when the birds have been reared together, and when the breeding stock is allowed a fairly free range.

The feeding and management of breeding stock is substantially the same as that of the laying flock. A higher percentage (about 2 per cent. more) protein should be included in the mash, and the birds should be allowed as much exercise as possible, not being confined in small runs or kept under the Hosier system. Absolutely free range, which is the ideal for breeding stock, is usually impracticable in this country on account of vermin. Where trap-nesting is practised, the eggs should, if possible, be graded, for it is frequently found that certain birds lay consistently small or mis-shaped eggs, unsuited for hatching purposes, and such stock should be discarded.

In the actual selection of the eggs themselves for hatching a good deal of care must be exercised. An egg weighing between $1\frac{3}{4}$ and 2 oz. is about the ideal size, and in addition care should be paid to such characters as shape, uniformity of shell, and cleanliness. The presence of an appreciable quantity of dirt closes the breathing pores. A slightly stained egg can, however, be cleaned with a dry or very slightly damp cloth.

All eggs to be used for hatching should be kept in a cool store with as uniform a temperature as possible, until it is desired to use them. They should be turned daily if possible during this storage period, and no egg more than ten days old should be used for hatching purposes. The practice of storing these eggs in bran or sawdust until required is not a very good one, and it is preferable to stand them on racks or other suitable container, so that air may circulate all round.

METHODS OF HATCHING

The majority of farmers in this country prefer to use incubators, but the broody hen has much to recommend it, and some of the larger poultry farmers in England are now returning to the use of these natural methods, believing that by so doing they retain the vigour and stamina of their stock. The great drawback in this country to the use of the hen is the problem of vermin, and unless the birds are clean this method should not be used. At least one farmer in this country has adopted the excellent practice of having the coops for sitting hens made out of sheet iron, so that they can be readily cleaned and freed from vermin. A series of these can be placed under a grass

roof so as to prevent them from getting too hot during the heat of the day. Where a large number of chicks are being hatched by this method it is desirable to tether each broody hen by one leg to its nest, and in this manner no confusion can arise when they are removed for feeding purposes. All sitting hens should be removed daily, and allowed access to corn and water, but laxative foods should not be fed, as this leads to fouling of the nest and eggs.

Towards the end of the incubating period it is desirable to damp the nest, for there is always a tendency for the eggs to become rather dry, and a certain loss through "dead in shell" will result. The advantages of the use of sitting hens may be summed up in a few words by saying that hatching by this method is simple when one is dependent on unskilled native labour, that the percentage hatch is usually greater than from an incubator, and that it is cheaper in first costs. The disadvantages are that many breeders who have only light breeds will have no sitting hens for the purpose, in which case it may mean keeping a certain number of birds of a breed such as the Light Sussex which has proved to be unsatisfactory from the utility point of view in this country on account of the relatively small number and size of the eggs it lays. Alternatively, it may be possible to obtain a certain number of native hens, but these are often covered with vermin, and being small will not usually cover the full number of eggs, and, lastly, it is difficult to obtain the required number of broody hens at any given moment.

The majority of breeders will therefore use the incubator, but in this case frequent and strict European supervision is necessary, without which it will be almost impossible to obtain good hatches. In this country, it would appear that the hot water incubators are definitely preferable to the hot air types, chiefly on account of the smaller temperature variations in the former. The author has traced several causes of poor results from incubators in this country to failure to test the capsule before every hatch. This can always be done by immersion in hot water, making sure that it expands fully. Frequently, also, buildings in which the incubators are housed are at fault. Ideally an incubator should be housed in a cellar with a through draught created by windows placed high up on either side of the room. In this manner a fairly uniform temperature is maintained and good aeration secured. The floor of the room should be firm and level, so that the incubator does not rock about, subjecting it to vibration. While the practical difficulties usually preclude the construction of a cellar in this country, yet the principles embodied can be preserved by constructing a thick-walled mud and wattle hut, roofed with corrugated iron, the whole roof being then covered thickly with a layer of grass, maize trash, etc., to ensure a uniform temperature. Ventilation should be provided in the manner described above. Preferably the hut should be situated where there is shade overhead. The incubator itself should be run empty for several days before it is used, to ensure uniformity of temperature before the eggs are introduced. The practice of marking each egg with a nought on one side and a cross on the other is always advisable, in spite of some opinion that this is not necessary, for only in this manner can complete turning be ensured, which is essential for successful results. The shallow troughs provided for water in the incubator should be kept filled, always filling with warm water, which will give off vapour immediately and maintain the necessary humidity in the atmosphere. The

floor of the incubator house should be covered with sand, which can also be kept damp. The most successful results seem to have been obtained by running at a temperature of slightly over the accepted figure of 103° F. up to 104° F. having yielded very good results. Great attention must be paid to the turning of the eggs, and they should be turned completely twice daily. Great care must also be exercised in the handling of the eggs, as the presence of one defective egg in the incubator can cause the liberation of gases which will prove toxic to the developing embryos.

The incubator should not be opened again after the 18th-19th day, depending on the temperature at which it has been running, but the thermometer must be examined very frequently after this, as heat develops rapidly as the young chicks respire actively in their shells. After hatching, no chicks should be removed from the brooder till thoroughly dry, but should be allowed to stay in the special compartment for this purpose. The latest hatched chickens may be left in the incubator after the others have been removed, and introduced into the brooder at night. For the first day the chicks require no food, but water and fine grit and shell should be provided. The practice of feeding hard-boiled egg is unnecessary, as the chick has considerable reserves of food in its body, which it requires to digest before it is induced to eat other foods. On the second day after removal from the brooder a mash can be commenced. A specimen is appended below. Skim milk should be fed separately to very young chickens, although if desired a very small quantity can be used to make the mash into a very stiff paste, which should be crumbly in texture. Where skim milk is not available, a proportionately higher amount of protein will be required, and the inclusion of 1 per cent. of cattle cod-liver oil is extremely desirable. Great care must, however, be taken in mixing this in with a mash, since it is important to incorporate it uniformly so that no excess will be present.

	Percentage Figures.		
	Brooder	*Grower*	*Fattenings.*
Pollards	50	45	30
Bran	20	28	14
Maize Meal	23	20	50
Meat and Bone Meal ..	5	5	4
Minerals	2	2	2
	100	100	100

Skim milk *ad lib.* to brooders and fattening birds; to others more limited quantities.

(*Note.* A brooder is a bird up to 8 weeks, and a grower any bird over this age up to time of laying.)

The ration inserted for fattening birds is a suitable ration for surplus cockerels which it may be desired to rear for table purposes. Chopped greenstuff in the form of cabbage or kale leaves or very finely chopped lucerne can be usefully incorporated in the mash, but on account of its rather fibrous nature, it is best not to use lucerne until the birds are eight weeks old. The small runs provided for the brooder chicks should be moved constantly and should always be kept on short grass; any long grass will inevitably lead

to chills and other troubles. Again one must emphasise the importance of segregation of age classes in rearing as well as in adult stock. The rather common practice of mixing rearing chickens of all ages is probably quite a possible cause for the appearance of a high percentage of "runts". All unwanted male birds should be selected as soon as possible, and fed on the cheaper ration outlined for fattening birds above. Where prices are low or demand poor for such birds this ration can safely be commenced at a relatively early age, so that costs may be brought as low as possible, and, if necessary, a portion of the mineral ration can be omitted. For young chickens the iron oxide is a most essential constituent of this ration, and should not be omitted. It is important to remember that iron is a very essential constituent of the blood, and lack of it may produce a fair proportion of wasters in the young stock.

A corn ration should be given to the rearing stock at the age of about four months, depending on the breed. If maize is used as one of the ingredients it should be kibbled small. Owing to the rapid rate at which stock grow and mature in this country, many farmers wish to retard their birds from coming into lay, in order that they may be given a good chance to grow out. The only way in which this can safely be done is to move them to fresh sites constantly, but any system such as reducing protein in the ration is to be deprecated in the case of a growing bird. Provided the birds have been well fed, there should be little danger in too early laying, and resort to drastic methods to delay this should not be adopted.

CONCLUSION

In this brief article an attempt has been made to show that, provided management is conducted on sound lines, there is a considerable future for poultry as a side-line to mixed farming activities in Kenya. It would appear likely that, with the present increasing production, the possibilities of export will again come to the forefront, and it will then perhaps be necessary for producers to accept a somewhat lower price than prevails at present, which will only be possible if continued progress is made on the lines of good management.

THE MANUFACTURE OF HUMUS BY THE INDORE PROCESS*

THERE is surely no technical subject on which all classes of cultivators are so closely in agreement as on the intimate relationship between productivity and the supply of organic matter in the soil. In our home agriculture, the quest for humus extends from large scale mechanized cereal farming at one end of the scale to intensive market gardening at the other. In the tropics, where the oxidation of organic matter takes place most rapidly, the provision of humic material is often the first step in land improvement. The more intensive the cultivation and the bigger the demands on the soil, the greater the need for steps to maintain the content of organic matter. In England, the very success and persistence of our traditional arable system, based on livestock and temporary grass, is a sign that it supplies the essential needs of the soil. Nevertheless, the question arises whether we are in general maintaining our soils in full productivity. Are we not supplying in the form of artificial fertilizers nutrients that would be better provided, or at least supplemented, by specially-prepared wastes derived from the farm, from industry, and from town refuse or sewage ?

To utilize waste organic matter, some form of composting is necessary. Compost-making is perhaps nearly as old as agriculture itself. In their various modifications, composting and the utilization of town wastes form the mainstay of the intensive farming of the thickly-populated and self-supporting districts of China and Japan. From time to time, scientific investigators have turned their attention to these matters, and have conferred precision on what had hitherto been a rule-of-thumb operation. Starting with the work of H. B. Hutchinson and E. H. Richards, whose first paper on "Artificial Farmyard Manure", appeared in this JOURNAL in 1921, the conditions underlying the rotting of straw and waste organic materials generally have been worked out. Another service which the scientific worker has been able to perform is to systematize existing knowledge and practices and draw up methods suitable for local supplies of waste materials, cropping systems, and labour conditions. Finally, there is the possibility of mechanization in its many forms, with the idea of reducing the labour costs of handling bulky material. The possibility of controlled compost-making has been eagerly taken up in many quarters, and there is already an extensive literature on the subject.

*Extract from *The Journal of the Ministry of Agriculture*, Vol. XLII, No. 11, February, 1936.

The Indore process of compost-making developed by Sir Albert Howard and his co-workers at the Institute of Plant Industry, Indore, Central India, from 1925 onwards, is already well known. The process was fully described in a book "The Waste Products of Agriculture", published in 1931, and more recent developments have been reported from time to time. In a lecture to the Society of Arts, on November 13 last, Sir Albert Howard gave an account of the present position and future prospects of the Indore process and its modifications; and, since it appears possible that certain aspects of the system may find application in British farming, the following notes may be of interest.

The Indore process is based on the idea that soils need organic matter, and that the waste organic matter derived from the unutilized parts of farm crops, from weeds and so forth, can supply this need, provided that they are first submitted to a preliminary rotting process. To promote this decay, an outside source of available nitrogen and mineral matter is required, these likewise being supplied by the farm itself in the shape of "urine earth" from the cattle sheds, and wood ashes respectively. The other additions are a certain amount of cattle dung, water, and air. The compost heaps are mixed, made, watered, and turned according to a carefully considered system; and, after they have undergone hot aerobic fermentation, the resulting product is a humic powdery material that has proved itself a useful organic manure.

Having developed the system and made it work on a large scale, the most ready avenue of development turned out to be by way of the plantation industries. The need for humus is almost universal, but the necessary organization and drive required to give a new process a trial were usually found in the directorate of some plantation group in London.

Sir Albert outlined recent progress with the use of composts on coffee, sisal and maize in Kenya, on tea and sugar-cane in India. Sugar-cane, maize and sisal, each provides residues in quantity, but the remaining crops need to be supplemented from outside sources to make up the required bulk of organic matter. In some circumstances, special crops of quick-growing grasses and legumes have been employed for this; the latter, in virtue of their high nitrogen content, serve to accelerate decomposition in the heap. Some difficulty is experienced in inducing peasant farmers to adopt the new method, and the procedure is to establish demonstration centres on Government farms or with influential agriculturists.

The next step is to attack the bigger problem of the utilization of the wastes of urban communities. A beginning has been made by the Indore workers in adapting their process to this purpose, and town waste is already being converted at a number of centres in India. The most promising development, from the point of view of western nations, is reported from Nairobi, Kenya, where by the composting of town refuse and various wastes

of the animal industries, a relatively concentrated organic manure is obtained, which is eagerly taken up by local cultivators.

Turning to home agriculture, Sir Albert Howard points out that certain existing practices are based on the composting principle. When, for example, clover or grass turf is dunged and turned over, the turf and dung are allowed to decay together. The suggestion is that, in our large areas of turf, we have a supply of potential humus that should be realized by means of composting *in situ* with dung. To provide the necessary dung, the existing manure would have to be supplemented by the incorporation of all available farm wastes into the dung heap. The place of artificials in a system based largely on humic manures would be to enrich the compost heap itself, thereby facilitating decay and grading up the final product. The ultimate disappearance of the water-borne sewage system is envisaged, to the gain of the soil in nutrients and organic matter.

Those who have what Sir Albert Howard calls the "NPK Mentality" may not agree in full measure with all his views. Some proposals are clearly for the future, and the present efficient fertilizer industry can reasonably and justly look to expansion in the role it has long occupied on most farms, namely the supplement to the home-produced animal manures. Nevertheless, the case for the salvage and utilization of organic wastes needs a strong advocate. The paper records substantial achievement, with every prospect of further development.

SOME ASPECTS OF THE PLANT VIRUS PROBLEM*

THERE appears to be rather a tendency on the part of botanists to consider the study of plant viruses a dull subject and one without any sure foundation in fact. It is hoped, therefore, in this short article to show that, on the contrary, the subject is not only an intensely interesting one, involving problems of fundamental biological importance, but is also of extreme economic importance and that plant virus workers really have a definite problem in hand.

No one at the present time knows what a virus is and this uncertainty as to its nature adds, perhaps, to the interest of the study. In speaking of a virus, stress is usually laid upon certain properties which are mainly negative in character such as inability to see the virus with the microscope, impossibility of cultivating the virus on media outside the host and the fact that viruses cannot be held back by the usual bacteria-proof filters. Improving methods of technique, however, are showing that some of these qualities are merely relative and it is already possible to photograph some viruses by means of the ultra-violet light microscope and to devise filters which will allow viruses to pass or hold them back at will according to the pore size of the filter.

In speculating upon the nature of viruses, whether of animals or plants, as a whole, it is well to remember that they are a heterogeneous collection of disease agents and it is by no means certain that they are necessarily all of the same nature. At one end of the scale is the virus of Psittacosis or parrot fever, the particle-size of which is 250 millimicrons (1 millimicron equals one-millionth of a millimitre) and which is in consequence within the range of the ordinary microscope. This virus appears to have a definite life cycle and is presumably a living organism. At the other end of the scale is the virus of foot-and-mouth disease which has a particle-size of about 10 millimicrons and is only two or three times the size of an oxyhaemoglobin molecule. It is difficult to conceive of this as a living organism. Certain plant viruses are also very small, the particle-size of tobacco necrosis virus is only 20-30 millimicrons and that of a newly described tomato virus is only 17-25 millimicrons. Again, there is the recent claim of Dr. Stanley (14) of the Rockefeller Institute in Princeton that he has succeeded in crystallising out the virus of tobacco mosaic which he considers to be an autocatalytic protein, *i.e.*, one which acts upon the cells of the host in such a way as to compel them to produce more of the same substance.

For the present it will perhaps suffice to adopt the definition of viruses given by Gardiner (5) —"as agents below or on the border-line of microscopical visibility which cause disturbance of the function of living cells and are regenerated in the process."

---

*Address by Kenneth M. Smith, D.Sc., Ph.D., Potato Virus Research Station, School of Agriculture, Cambridge, to Section K, British Association Meeting, Norwich. Reproduced from *The Rhodesia Agricultural Journal*, Vol. XXXIII, No. 2, February, 1936.

In this short survey of the plant virus problem, it will only be possible to deal with one or two of the more interesting aspects of the subject and it is proposed, first of all, to discuss a few of the symptoms produced in affected plants. Since the pathological effect on the plant is almost the only criterion of the existence of a plant virus, the study of symptoms necessarily plays rather a large part. There are various kinds of virus diseases which may be loosely grouped together as follows, the *mosaic* type where attack on the chlorophyll induces the formation of mottlings or rings ; the *destructive* type which induces necroses of the cells in leaves and stems, and a third type which produces *deformities* or *overgrowth* in the affected plants.

Some of the mosaic viruses produce colour changes in the flowers of affected plants. Perhaps the best known example of this phenomenon is the so-called "Tulip-breaking" in which tulips affected with a mosaic virus produce variegated flowers. Certain of these tulips with variegated flowers at one time fetched large sums of money owing to the mistaken idea that they were new varieties, whereas they were in reality only diseased specimens of self-coloured varieties. References to this tulip "breaking" may be found in the literature of very early times. Thus, the first record is a description published in 1576, and other accounts of this variegation in tulips appeared in 1622 and 1670. It was in this latter account that the suggestion was first made that the variegated tulip might be diseased. In the Rembrandt Exhibition recently held in Amsterdam were paintings of tulips by Dutch artists of the sixteenth and seventeenth centuries, and many of these tulips showed a typical mosaic infection. Just recently, growers of the favourite blood-red variety of wallflower have been perturbed by the appearance of an ugly yellow stripe or flecking in the red flowers and this has led to many complaints from customers that their colour schemes have been spoiled ; similarly with self-coloured stock (10). The variegation in these flowers has been shown to be due to a virus carried to the plants by a species of greenfly from virus-infected broccoli of cauliflowers in the neighbourhood.

In the writer's opinion viruses play a larger part in the production of variegations in flower colours than is usually supposed. For instance, inoculations from the petals of common variegated mauve and white and mauve and yellow violas, picked at random from the garden, to healthy tobacco plants of the White Burley variety, produced in those plants a virulent mosaic disease. The virus is also capable of infecting several other species of Solanaceous plant. Experiment seems to show that the virus causing this variegation is a strain of cucumber mosaic virus (cucumber virus 1).

Some of the mosaic viruses affecting ornamental plants may produce little effect on the plant other than the change in the colour of the flowers. It is quite likely therefore that a systematic enquiry into the question would show that other familiar flower variegations may be due in part to virus infection. There seems, however, to be a common element in the appearance of this type of variegation, *i.e.*, a pencilling or flecking of the colours and a break in the hard line dividing two colours.

The next question is the important one of how plant viruses are transmitted in nature from diseased to healthy plants. The majority of plant viruses depend upon insects for their dissemination from plant to plant and

this relationship between insect and virus is one of considerable interest. The insects concerned in the spread of plant viruses are nearly all of one type, a type of insect which feeds in a particular way which seems to be well adopted for the injection of the virus into the plant. These insects belong to the order Hemiptera and are of the sap-sucking type.

Insects are not merely mechanical vectors of the virus but in all probability some kind of obligate relationship exists between the two. The following facts seem to bear this out—certain viruses cannot be transmitted from diseased to healthy plants except by the agency of insect and often only by one species of insect or one type of insect and not by other closely related species ; some insect vectors having fed once upon a virus-diseased plant remain infective for the rest of their lives without the necessity for further recourse to a source of virus infection. This suggests that the virus actually multiplies in the body of the insect. Further, some insects do not become infective until a minimum time has elapsed after feeding upon a virus-infected plant. This is often referred to, perhaps on insufficient grounds, as the "incubation period" of the virus in the insect. A better term would be " a delay in the development of infective power within the insect". This day may be as long as ten days in some cases.

It is not possible to deal at length with the question of the insect relationships of plant viruses, but space permits touching upon some recent interesting work on this subject. Storey (15), working upon the leaf-hopper which transmits the streak disease of maize in East Africa, has found that there exist two distinct races of this insect. One race which can transmit the virus and one race which is unable to do so ; these races are termed *active* and *inactive* respectively. There is no visible difference between the inactive and active races and both are of the same species. Further, Storey has shown that if a puncture is made with a fine needle in the wall of the gut or alimentary canal of the inactive insect, the insect then becomes capable of transmitting the virus. It would appear from this that there may exist some factor or factors connected with the structure of the wall of the alimentary canal in inactive insects which prevents the virus from passing through into the blood and so reaching the salivary glands whence it is injected into the plant.

The next point concerns the mechanism of movement of the virus in the plant. Since most viruses rapidly become systemic in their hosts, there is evidently an efficient means of transport about the plant. It has been shown by Bennett (1), Caldwell (2) and others that if the phloem in a portion of the stem of a plant is destroyed by steaming, the virus cannot pass over this bridge of dead tissue. In other words the virus is moving in the phloem, but not in the xylem. The disease will develop normally in whichever half of the plant is inoculated, but the virus will not pass from the upper to the lower nor from the lower to the upper half, across the bridge of dead tissue.

The general movement of a virus about the infected plant has been well demonstrated by Samuel (9). His experiments show that there is no movement of tobacco mosaic virus from the inoculated leaf for a period of 3-4 days. The virus then passes out of the inoculated leaf and travels rapidly to the roots of the plant ; about a day later it travels with equal rapidity to the top of the plant. In pot plants the more mature leaves become

successively invaded from the top downwards and from the bottom upwards until the plant is completely invaded by the virus.

The movement of the virus in the plant thus seems to be of two kinds: first, a very slow cell-to-cell movement via the connecting protoplasmic bridges until the phloem stream is reached, when the main and most rapid movement about the plant begins. Further confirmation of this is afforded by some experiments with a newly discovered virus known as tobacco necrosis (13). This virus produces only necrotic symptoms and thus etches out, as it were, its own movement through the plant. Photographs have been taken at two-day intervals of the path followed by the virus in the leaves of cowpea (*Vigna sinensis*). The first six photographs show merely a gradual increase in size of the lesion at the point where the virus has entered the leaf. As soon, however, as the virus enters the phloem it begins to travel rapidly through the leaf, moving in 48 hours over a much greater distance than in the whole of the preceding 12 days' slow cell-to-cell movement.

On another aspect of the subject two interesting discoveries have recently been made: firstly, it has been found that some plant viruses exist in a number of closely allied strains, and secondly, it has been shown that infection with one strain of a virus will immunise a plant from infection with another strain of that virus. Space will not suffice to allow of a discussion as to whether these strains actually arise by mutation from existing strains, but the evidence rather indicates that this is the case.

The immunity conferred upon a plant by a virus strain against other strains of the same virus is of the non-sterile type. There is apparently no question of the production of antibodies and it is the presence of the first virus which inhibits the entrance of the second strain. This type of immunity is well shown in the case of potato virus X (8), tobacco (6) and cucumber mosaic viruses (7) and by the virus of tomato streak (11). All these viruses exist in strains and the "green" and "yellow" strains of the tobacco or cucumber viruses are particularly suitable for this kind of experiment. If a healthy tobacco plant and one systemically infected with a "green" strain of tobacco mosaic are inoculated with a "yellow" strain, the healthy plant develops the yellow spots characteristic of this virus, while the plant already infected with the "green" strain is protected against invasion by the "yellow" strain. A similar protective action is exerted in the case of a plant infected with a "yellow" strain against invasion by the "green" strain. It should perhaps be emphasised that the presence of one virus in a plant is no bar to the entrance of a second virus of a different type, the cross immunity holds good only for like viruses and virus strains. This kind of immunity therefore is likely to prove a useful tool in the work of classifying viruses and in distinguishing like from unlike viruses in those cases where diagnosis by symptoms alone is unreliable.

A possible practical application of this type of immunity lies in the protection of a crop from infection with a severe virus by previous artificial infection with a mild strain of the same virus. Here, however, lie a number of pitfalls, chief of which is the unfortunate liability of certain viruses, even when in a mild form, to give rise jointly with another virus of a different type, to a much more severe disease than is produced by either virus acting separately.

Mention must be made of a comparatively new method of approach to the plant virus problem, *i.e.*, the discovery that the intraperitoneal injection

of rabbits with plant virus extracts induces the production of *antibodies* in these animals. These antibodies react specifically with the *antigen* (virus sap) in some observable way. Three types of immunologic reactions have been demonstrated, complement-fixation, precipitation and neutralisation of the pathogenic properties of the virus. Such neutralisation is specific for each virus, thus, tobacco mosaic virus is inactivated only by anti-tobacco mosaic serum, and tobacco ringspot virus only by anti-tobacco ringspot serum, and so on. The cross specificity is absolute and the addition to any of the viruses of a heterologous antiserum exhibits no effect. This specificity, however, does not extend to distinctions between virus strains even when the strains produce very different symptoms in ths host plants. (Chester (3)).

This new technique is likely, therefore, to prove a useful tool in the difficult task of classifying and differentiating plant viruses.

Since viruses are so often spoken of as filter-passing or ultra-microscopic, and described by other adjectives referring to their small size, it may be of interest to give a few details of the actual magnitude of some viruses. The sizes of virus particles can be measured with fair accuracy by means of ultra-filtration through collodion membranes, the pore size of which can be measured. These membranes are prepared by a special technique devised by Dr. Elford (4) of the National Institute of Medical Research at Hampstead and the process of their manufacture is too complicated to describe here. It has been found by the application of this technique that plant viruses vary very much in their particle size, ranging from 75 to 100 millimicrons for a potato virus down to 17-25 millimicrons for a new tomato virus.

In conclusion, it is proposed to give a short account of an interesting new virus, because it well illustrates the kind of problem with which the virus worker is sometimes faced. It has been found at Cambridge (12) that a high proportion of the normal stock of healthy tobacco plants carry a virus in the roots but not in the stem and show no signs of disease during the whole of their life. Under certain conditions, however, in the winter and early spring the virus may pass up into the plant and develop disease symptoms in the lower leaves. Unlike most other plant viruses, this virus does not become systemic in the host. Further, and this is the most interesting point, tobacco seedlings which by available methods of inoculation have been shown to be virus-free, yet contain the virus in their roots in quite large quantities some five weeks later. The following experiment illustrates this. Seed from a White Burley tobacco plant grown in the insect-proof house was sown in sterilised sand in a "cellophane" cage in the glass-house. From the resulting seedlings a number of small plants were chosen and all the roots cut off except that one root was left on each plant. The roots of each plant thus removed, were ground up and the resulting paste inoculated separately to three or four cowpeas, a plant which is extremely sensitive to the virus. The tobacco plants were then repotted in sterilised soil and allowed to grow on ; from this number 48 plants, the roots of which had given no reaction upon the cowpeas, were selected for a second test. This was made, again to cowpeas, 5 weeks after the first test. The plants were by this time about 8 inches across with a well-developed root system, and showed no unusual symptoms. Of these 48 plants 32 gave a virus reaction. In considering these results certain other facts must be borne in mind ; exhaustive tests make the possibility of outside infection by seed, soil or

water-transmission unlikely, though seed transmission in some form cannot definitely be excluded. The virus is not insect borne.

There seem to be three possible explanations of this problem: first, it may be assumed that the virus is present all the time in the stem, but present either in a non-virulent form which requires to gain virulence by concentration in particular cells of the root, or else in a dilution too great to give a positive reaction on inoculation. This theory, of course, involves seed transmission of the virus in undetectable form or quantity. The second possible explanation is that the virus is arising spontaneously within the plant. The third possibility, and perhaps the least likely, is the existence of a mode of virus transmission at present quite unsuspected.

Virus workers have long dallied with the idea that a virus might arise *de novo* within the host. Such a suggestion is attractive in some ways and it would explain many things which are at the moment obscure. If viruses are considered as organisms or at least possessing some of the attributes of life, the suggestion of their heterogenesis is repugnant. If, on the other hand, Stanley's view that a virus may be an autocatalytic protein is accepted, then there seems no particular reason why the theory of spontaneous development of the virus within the host should not also be accepted. It is, however, at present still an open question and much work remains to be done before this question can be answered.

REFERENCES

1. Bennet, C. W.—(1927), Agric. Exp. Stat. Mich. State Coll. Tech. Bull 80.
2. Caldwell, J.—(1930), Ann. Appl. Biol. 17, 3, 429-443.
3. Chester, K. S.—(1934), Phytopath., 24, 11, 1180.
4. Elford, W. J.—(1931), Journ. Path. and Bact., 34, 505-21.
5. Gardner, A. D.—(1931), Microbes and Ultramicrobes, Methuen's Biological Monographs.
6. Kunkel, L. O.—(1934), Phytopath., 24, 5, 437-66.
7. Price, W. C.—(1934), Phytopath., 24, 7, 743-61.
8. Salaman, R. N.—(1933), Nature, 131, 468.
9. Samuel, G.—(1934), Ann. Appl. Biol., 21, 1, 90-111.
10. Smith, Kenneth M.—(1935), Gard. Chron., 2537, 112.
11. ——(1935), Parasitology, 27, 3, 450.
12. ———(1935), Nature, 136, 395.
13. ——and Bald, J. G.—Parasitology, 27, 2.
14. Stanley, W. M.—(1935), Science, 81, 2113, 644-5.
15. Storey, H. H.—(1933), Proc. Roy. Soc. B., 113.

PLANTS AND ANIMALS IN HUMAN HISTORY*

THE Industrial Revolution has changed the life of this country very completely, but two other revolutions in the past were equally important—the domestication of animals and that of plants. Each made as great a change in human society as did the harnessing of steam power. When we look back at the past we are apt to think that when most of the people lived on the land as farmers or in close connection with the farm they were leading a natural life. That is nonsense. A farm is as unnatural as a motor-'bus or a blast furnace. If England were left to itself it would be covered with forests, moors and marshes. The farmer works on ground which has been cleared of trees or drained. He spends his time looking after most unnatural plants, such as wheat and potatoes, which would not stand a chance in competition with weeds, if men were not there to protect them ; or unnatural animals like cows, which produce far more milk than their children need.

Agriculture is a very recent invention. For hundreds of thousands of years man had been a hunter like the men of the old Stone Age who hunted the wild horse and the mammoth, or a food gatherer like those other Stone Age men who left great mounds of oyster and mussel shells on the coast of Denmark.

The first animal to be domesticated was almost certainly the dog. This happened about the end of the old Stone Age. Probably the dog was at first a scavenger, and later made himself useful as a watcher at night and a helper in hunting, and delightful as a pet. But he has been part of human society for much longer than any other of our animals, which is probably one reason why we understand him, and he us, so much better than any of them.

Though the dog was very useful to man, he did not revolutionise human life. But one day a hunter thought of keeping some wild animals alive. Perhaps at first they were just tied up for a few days and then killed, or perhaps a herd of cattle was followed about and protected from wolves. Some people think that young animals were first kept as pets. But a time came when a family or a tribe had so many domestic animals that they could give up hunting and live on the meat of their flocks.

SHEPHERDS V. HUNTERS

This meant an enormous change. The same area of land could support far more people, so the shepherds crowded the hunters out. Of course

*By Professor J. B. S. Haldane in *The Listener*, Vol. XV, No. 370, 12th February, 1936.

there were fights, like the fights which occurred in North America and Australia between European settlers and native hunters who thought that any animal was fair game. But in the long run the pastoral peoples occupied those areas which were most suited to them. Now a hunter can own little except his weapons and a few skins. But cattle and sheep are a form of wealth which multiplies itself. The man who first owned a herd was the first rich man. He could hire a poorer man to look after his animals. If you want a picture of this sort of society, read the book of Genesis, and especially the story of how Jacob served Laban. You will find the beginnings of capitalism and the division of society into property owners and hired workers.

Not only did human society change, but the animals too. They got tamer, perhaps because the wilder ones ran away. They became more fertile and fatter, especially when men began selective breeding. At first they were only used for meat and skin, but later for milk and wool, for carrying burdens and ultimately for pulling wagons. Most of these old shepherds were nomads, driving their flocks from one pasture to another. The day on which some great genius induced an animal to carry his pack was an important day in human history. It meant that many new forms of wealth could be accumulated. Tents and pottery, and even changes of clothing, could be carried.

The second revolution came later, at least in Europe and Asia, when men began to protect certain plants as they protected animals. One of the oddest facts about man is his dependence on a quite small group of plants. There are 332 different families of flowering plants, such as the *Rosaceae*, like the rose and apple, and the *Compositae*, like the daisy and thistle. But one family, the *Gramineae*, or grass family, is of more importance to us than all the others put together. It includes the cereals, such as wheat, oats, barley, rice and maize, the grasses, and the giant tropical bamboos and sugar canes. If we eat bread we live on grasses at first hand. If we drink milk, or eat cheese, butter, beef or mutton, we live on them at second hand.

IF THERE WERE NO GRASS?

If a plague wiped out the grasses, most of the human race would die. If all other plants perished, we should have no fruit, no flowers, no potatoes, no wood. But some kind of civilisation would be quite possible.

We do not know just how or when plants were domesticated, but we do know where, and we are fairly sure that it happened within the last eight or ten thousand years. Let me explain how people traced back the origin of agriculture. You probably know that maize and potatoes both came from America. Now in the Old World there are only a few sorts of maize and potatoes, and in America there are a great many different sorts, and also wild plants which are so nearly related to them that they can be got

to breed with them. So if we did not know where maize and potatoes came from, we could easily find out.

The Russian botanist, Vavilov, applied this principle in the Old World. He noticed that there are sixty different sub-species of bread wheat in Afghanistan and only twenty in the whole of Europe, so he concluded that bread wheat originated in, or near, Afghanistan, while on the other hand macaroni wheat originated somewhere near the Eastern Mediterranean. Most of our cultivated plants originated in mountainous areas. For example, many of our barleys and meadow grasses came from Abyssinia, potatoes from the Andes, cherries from Armenia, and so on.

Now when a plant like wheat is domesticated it changes very quickly. Suppose you have two wheat plants growing side by side, and one produces a hundred seeds, the other only fifty, perhaps because it uses up more of the sugar which it makes in its leaves to grow a good set of roots. Further, suppose the difference between these two plants is inherited. The seeds from thousands of wheat plants are gathered. Some are made into bread, some sown to give a crop next year. The plant with a hundred seeds will probably contribute twice as much to the next generation as the plant with fifty. So in a few years the more fertile sort will quite oust the less fertile. It will probably be a worse plant in other ways. If its roots are shorter it will be less able to stand drought, and so on. But you see how, without any conscious selection, wheat and other similar plants became more economically valuable, and also came to need much more care. Now just as animal husbandry enables a square mile to support more men than hunting, so agriculture gives a denser population than animal breeding, and also a more settled one. After a time agriculture came down from the mountain valleys into the basins of great rivers, the Nile, the Euphrates and the Indus, and there for the first time men began to live a life which we should call civilised.

But there was an inevitable conflict between the men who lived mainly on vegetables and those who kept flocks. In the fourth chapter of the book of Genesis you can read that Abel was a keeper of sheep and Cain a tiller of the ground. There is little doubt that the story of their quarrel symbolises the struggle which was always going on between the keepers of sheep and the tillers of the soil on the borders of Mesopotamia, and does to this day. The sheep will trample down the corn. The agriculturists will plough up land which the shepherds had used for grazing their flocks. No wonder a little further on in the book of Genesis we read that 'every shepherd is an abomination to the Egyptians'. It took thousands of years before the shepherds and the tillers of the soil, the imitators of Abel and Cain, could live in peace together. And it was only in the eighteenth century, when men learned to feed sheep on root crops during the winter, that they really began to co-operate fruitfully.

A SOCIETY WITH NO DOMESTIC ANIMALS

What I have just told you is true for the Old World, but things were very different in America. There then were very few domesticable animals, and men went straight from hunting to agriculture. The bison was too big, and perhaps too fierce, to tame, and the llama was a very poor substitute for the sheep and horse. If you read about the civilisations of Mexico, such as the Aztec empire, you will be struck by their extraordinary cruelty. Thousands of men and women were sacrificed in the most horrible way to their gods. Some people have thought that they must have been a naturally cruel race. I don't believe it. Try to imagine a society, not only without machinery, but without horse, oxen, or any other animals to carry or pull heavy loads; with man as the one source of power. In such a society men will be treated as animals. At one time or another most peoples have thought that their gods needed human sacrifices. But where domestic animals were available instead, they started sacrificing them, as you may read in the story of Abraham and Isaac. In Mexico they had this idea of the necessity of a bloody sacrifice, but no animals to take the place of men and women as victims.

There is one domestic plant which I have not yet mentioned—a plant too small to see without a microscope, namely yeast. There are many different kinds of yeast. Some kinds make bubbles when added to dough, so that it bakes into bread instead of a sort of biscuit. Some cause sugar to ferment into alcohol, and thus make beer and wine. The different sorts are carefully grown for their jobs. A bread yeast will no more make good beer than a carthorse will win the Derby. There is no doubt that the bread-making yeasts are friends of man, but many people think that the kinds which make alcohol are among our enemies.

ENEMIES OF MAN

Now I am going to say a few words about the plants and animals which are certainly our enemies. I shall not trouble with lions, tigers and wolves, or even with poisonous snakes. They are quite unimportant compared with the microscopic plants and animals which cause infectious diseases, and the insects which carry them from one person to another.

It is hard to say just how much history these little enemies of man have made, because their deeds are not carefully recorded. But they make the historians' accounts of war look pretty silly. I think it is fair to say that in the large majority of wars until quite recently, most of the soldiers were killed, not by other men, but by microbes. For example the various armies fighting against the Russians in the Crimean War lost 70,000 men in battle and 182,000 from disease.

Sometimes a disease defends a country. For example, although the British have conquered a good deal of West Africa, they have never colonised it. And one of its chief defenders is the mosquito transmitting yellow fever, which is deadly to white men, but not to negroes. Quite as often the disease

helps the invaders. A good many of the Red Indians in Canada and the United States were killed by white men, but far more by small-pox. The gentle Polynesians in the Pacific Islands were largely killed by measles. One quarter of the inhabitants of Fiji died of that disease in three months in 1875 Their ancestors had never had measles, so they had developed no protection against it. If either the Red Indians or the Polynesians had possessed an ally like yellow fever, the history of North America and the Pacific might have been very different.

Yellow fever is carried by a mosquito which sucks in the parasite when it bites a patient, and then infects people whom it bites later on. A number of less deadly diseases, such as malaria, are transmitted in the same way. So we can prevent yellow fever by abolishing mosquitoes. This can be done by draining stagnant water, where they breed, and also by using a rather curious ally, a little fish which eats the mosquito larvae. One or two of these fish are put in every water tank in many towns in Central and South America, and they have been free of yellow fever ever since.

You may ask what that has to do with history? A great deal. In 1880 a company managed by the great French engineer, de Lesseps, who had designed the Suez Canal, started to make a canal across the Isthmus of Panama. They were beaten, very largely by yellow fever. The present canal was made by the American Government, but not until American doctors had discovered the mosquito that carries yellow fever, and wiped it out. Instead of being international or French, the canal belongs to the United States Government, and this fact has a very important bearing on international trade, and may have a decisive influence on a future naval war.

I haven't said anything about the silk-worm, one of our queerest domestic animals, or about the great caravan routes across Asia by which Chinese silks were brought to Europe, until two Persian monks smuggled some silk-worm eggs out of China to Constantinople in a hollow cane. For when trade is difficult, rare animal and plant products play a very important part in it. The Portuguese who discovered the passage to India round the Cape of Good Hope were largely after pepper. Canada was explored in the search for furs. Trading posts were opened on the coasts of West and Central Africa because of the value of ivory, which, of course, is made from elephants' tusks. But all that is part of the romantic side of history. I want you to think more of the practical everyday side, to realise that the kind of civilisation possible in any country, besides depending on the sort of men, who live in it, depends also on the sorts of plants and animals, not only visible, but microscopic. If we can realise how a great invention like agriculture changed history, it will help us to understand the changes which are taking place today through the adoption of machinery. A factory worker minding a machine is as different from a handicraftsman—a better man in some ways and a worse in others—as a shepherd from a hunter. When the form of production changes, the whole structure of society changes with it. Our society is changing. That is why politics are so interesting. If we remember the tragedy of Cain and Abel, and learn from it, we may be able to make the necessary changes without shedding our brothers' blood.

MEETINGS, CONFERENCES, ETC.

COCONUT RESEARCH SCHEME (CEYLON)

Minutes of the thirty-first meeting of the Board of Management of the Coconut Research Scheme, held at Bandirippuwa Estate, on Friday, February 21, 1936, at 10 a.m.

Present.—Dr. J. C. Hutson (in the chair), Mr. C. H. Collins, C.C.S., Treasury Representative, Mr. L. W. A. de Soysa, Mr. Wace de Niese, Mr. Austin Ekanayake, Mr. D. D. Karunaratne, J.P. and Mr. W. V. D. Pieris, Officiating Chief Technical Officer, who acted as Secretary.

Apologies for absence were received from Mr. A. W. Warburton-Gray and Mr. J. L. Kotalawala.

MINUTES

The minutes were passed with one amendment and signed by the Chairman.

OBITUARY

A vote of condolence was passed on the death of His Majesty King George V.

The Chairman also referred to Sir Marcus Fernando, who was one of the members of the first Board of Management and whose death had been a serious loss to the Coconut Research Scheme. The Board passed a vote of condolence on his death.

ANNUAL REPORTS

The Board decided that Mr. Warburton-Gray's written comments regarding dead palms should be added to the Annual Report before section *Finance* as follows :—

"*General.*—The Board commends to Estate Proprietors and Superintendents the desirability of getting rid of dead palms on their estates."

The Annual Report of the Board of Management, Coconut Research Scheme, for 1935 and the Auditor-General's Statement were passed without further comment.

FINANCE

(*a*) The Statement of Receipts and Payments for the 4th Quarter of 1935 was adopted.

(*b*) The Chairman explained that certain accounts had not been submitted in time for payment from the 1935 Votes under the heads of *Laboratory Equipment* and *Running Expenses of Electric Plant*, and asked the Board's permission to pay these accounts from the balance unexpended at the end of last

year. The Board decided that the Laboratory Equipment Vote for 1936 should be increased by Rs. 850 but that other accounts should be met out of the estimates for 1936.

(*c*) The Chairman informed the Board that a temporary arrangement had been made with the Bank regarding the signing of the Schemes' cheques by Mr. Pieris "for Director of Research," instead of as Officiating Chief Technical Officer. The Board agreed to this arrangement. The Chairman also informed the Board that a rubber stamp had been made for use with the Scheme's cheques on termination of the temporary arrangement.

ELECTRIC PLANT

After consideration of Messrs Brown & Co.'s Reports on the Electrical Installation at Bandirippuwa the Board decided to adopt the "Multi-Path" carbon lightning arrestors for the main overhead lines connected to the Senior Power House, as recommended in their First Report, dated 23rd December, 1935. Mr. Pieris stated that the greater portion of the other urgent recommendations in that report had been carried out already with the exception of the rectification of certain leaks in the Director's Bungalow. The Board decided that re-wiring in this bungalow should be done as suggested by Mr. Pieris.

With reference to Messrs Brown & Co.'s Second Report, dated 10th February, 1936, Mr. Wace de Niese moved that, if Mr. Pieris was satisfied with the scheme of alterations suggested in this report and that if Messrs Brown & Co. would furnish a guarantee that the whole electric installation at Bandirippuwa Estate could be made thoroughly efficient thereby, the proposals as stated in their second report be adopted. Mr. L. W. A. de Soysa seconded. Mr. Pieris stated that, as far as he could see, the proposed alterations suggested by Messrs. Brown & Co. would solve all the present difficulties. The motion was carried unanimously.

ESTATE

(*a*) *Progress Reports for November and December*, 1935 *and January*, 1936.—The Progress Reports for November and December, 1935, were adopted without comment.

In reply to Mr. Warburton-Gray's written comments regarding the sale of nuts on Bandirippuwa Estate, Mr. Pieris stated that this Estate could be regarded as being under two different types of management. Firstly, there was that section under Research Management, embracing at present the total area under manurial experiments and yield-recording, amounting to 34 acres. The nuts from this area were being cured on the estate as part of the experimental procedure. To this could be added the area under green crops, amounting to 37 acres, the nuts from which would also, in time, be converted into copra on the estate. Certain data regarding out-turn could be obtained in this manner.

Secondly, there was that section of the estate under normal estate management. This area was worked on purely business lines and could be used as an example of coconut cultivation for profit. As a result of running that

section of the estate on those lines, it was possible for the technical officers of the Scheme to keep the economics of coconut cultivation in mind as well as its technical aspects and also to understand the problems of the average coconut planter. The nuts from this area were sold or converted into copra according to the condition of the market for coconut products. When desiccated coconut was selling better than copra, as had been the case for some time, the nuts were sold profitably to local desiccated coconut millers. The question then was whether the nuts from the area under normal estate management should be disposed of in the most profitable manner or turned into copra on the estate in order to obtain out-turn figures. Mr. Pieris further stated that, if the Board had no objection, there was a way out of the difficulty. If the relation between the weight of husked nuts and the weight of copra, which had been established experimentally, was made use of, it was possible to obtain reasonably accurate out-turn figures by dealing with representative samples from each field on the estate. The size of a " representative sample " could be ascertained experimentally. The Board decided that in future out-turn figures should be obtained in that manner. Mr. Pieris also pointed out that, as the area under experiments increased, the number of nuts cured on the estate would increase proportionately.

Regarding Mr. Warburton-Gray's written comments on the sale of leaf-butts, Mr. Pieris reported that this had now been stopped and that instructions to that effect had been issued to the Superintendent of the estate.

Regarding the various items under *Contingencies* in the Progress Reports, it was decided that the number of such items should be reduced as much as possible.

(*b*) *Statement regarding the disposal of husks from Bandirippuwa Estate.*—The Board decided that since Mr. Warburton-Gray considered this an important matter, it should be brought up again at the next meeting for discussion. It was decided that, in the meantime, if Mr. Pieris was satisfied that husks were not required on the estate, he might sell them.

JUNGLE AREA FOR EXPERIMENTS

The Chairman read a letter from the Assistant Government Agent, Puttalam on this subject and after some discussion it was decided that Mr. Pieris should get into touch with the Assistant Government Agent early regarding the possibility of acquiring a piece of Crown Jungle for the use of the Coconut Research Scheme. Further discussion on another possible area of jungle was postponed until the next meeting.

COPRA KILN

After hearing the report of Mr. Wace de Niese on this subject, the Board agreed with his remarks and it was decided to leave the whole matter in the hands of the Coconut Board. Mr. de Niese agreed to report further on the action which that Board had taken.

EXPERIMENTAL

The Soil Chemist's Report on " Manuring Experiments " was considered in conjunction with Mr. Warburton-Gray's written comments thereon.

Mr. Pieris stated that Block I. (Kotakande) had been planted up with cover crops at the end of last year with a view to commencing an experiment on the utilisation and treatment of cover ; and that it might be possible to lay down a controlled experiment similar to the manurial experiment already started by the Soil Chemist. He further remarked that since Block I. was already sown with uniform cover, the adoption of Mr. Warburton-Gray's suggestions regarding this Block would seriously interfere with the experiment already taken in hand. Regarding Mr. Warburton-Gray's question whether further manuring experiments could not be laid down on a neighbouring estate, Mr. Pieris drew the attention of the Board to paragraph 4 of the Soil Chemist's Report where it was stated that further experiments would have to be carried out on other estates. Mr. Pieris again explained the difficulties involved in field experiments carried out on uneven land containing heterogeneous soil types, and stated that, as suggested in section II. of the Report under consideration, the portions of the estate mentioned in sub-sections 4 and 5 of that section could be used for demonstration experiments and for the study of special problems such as the cultivation of fruit trees and fodder crops.

The Board agreed with the experimental programme carried out so far, but requested that a further programme be drawn up regarding the use of that portion of the estate not under experiments at present. Mr. Pieris undertook to get that programme ready at an early date. The Board also decided that there should be no interference with existing experiments.

MISCELLANEOUS

The Chairman read a letter from the Secretary of the Chilaw Planters' Association dated January 16, 1936, thanking the Board for permission granted to that association to hold one meeting a year in the Coconut Research Scheme Library.

The Chairman reported that the three Senior Technical Officers of the Scheme had been elected to serve on the Coconut Planters' Joint Committee and that the permission of Board Members had been obtained by circulation of papers to allow that Committee to hold two meetings a year at Bandirippuwa Estate, on the third Saturday of January and July respectively.

The meeting terminated at 12·15 p.m.

TEA RESEARCH INSTITUTE OF CEYLON

Minutes of a Meeting of the Board of the Tea Research Institute of Ceylon held in the Ceylon Chamber of Commerce Rooms, Colombo, on Saturday, the 22nd February, 1936, at 10 a.m.

Present.—Mr. James Forbes (Jnr.), (Chairman), The Hon'ble the Financial Secretary, (Mr. H. J. Huxham), Messrs. I. L Cameron, R. P. Gaddum, J. D. Hoare, J. C. Kelly, D. T. Richards, A. W. L. Turner (Secretary, T.R.I.) and by invitation Dr. Roland V. Norris (Director, T.R.I.) and Mr. J. W. Ferguson (Visiting Agent of St. Coombs).

Absent.—The Director of Agriculture, Col. T. G. Jayawardene, V.D., Messrs R. G. Coombe, E. L. Fraser and D. H. Kotalawala.

1. Notice calling the Meeting was read.

2. The Minutes of the Meeting of the Board of the Tea Research Institute of Ceylon, held on the 11th January, 1936, were confirmed.

3. MEMBERS OF THE BOARD OF THE T.R.I.

Announced that Mr. I. L. Cameron, one of the Representatives of the Ceylon Estates' Proprietary Association on the Board completed his three years' term of office on the 28th January, 1936, and that he had been re-nominated for a further period of three years.

4. JUNIOR STAFF

Research Assistant, Agricultural Chemistry—Dr. J. G. Shrikhande.—Announced that this Officer took up his duties on the 21st January, 1936.

5. RULES OF THE BOARD OF THE T.R.I.

The latest copy of Draft Rules, referred to as Draft Rules "A" which had been sent to all Members of the Board on the 11th February, 1936, were considered, and subject to certain alterations the Rules were approved.

SECRETARY OF THE BOARD, T.R.I.

Arising out of the amended Rules the following resolution was passed :—

"That as from the 1st April, 1936, the Director shall be appointed Secretary of the Board."

A. W. L. TURNER,
Secretary.

REVIEW

ARBEITEN ÜBER KALIDÜNGUNG POTASH RESEARCH—Vol. II.*

THIS interesting and useful publication of 478 pages contains an account of the research work conducted on the potash question at the Berlin-Lichterfelde Agricultural Experiment Station since the issue of the first report three years ago. The book is written in German, but the excellent summaries at the end of each chapter indicate clearly the comprehensive and yet thorough nature of the investigations carried out on various aspects of the subject. The scope of the book is well set out in the preface.

In Part I. the investigations relative to soil research proper are described. Great importance is placed, and rightly so, on the study of the water economy of plants and suitable methods have been elaborated for the purpose. On the chemical side attention is directed mainly to the soil solution and soil colloids as these are the main sources of plant nutrient supply. From the results of these studies a method of determining the fertiliser requirement of a crop under a given set of conditions is worked out. The remaining chapters of this part of the book deal with the application of the Lichterfelde method to investigations on the soils of Egypt and the Sudan and certain Dutch soils. In this connection reference is made to the apparent non-response of some crops to potash manuring on certain soils. This phenomenon can be attributed to the deficiency of the soil colloids in potassium and the ease with which this element is therefore absorbed by the former. Abnormally high potash applications are indicated on these soils.

Part II. deals with the physiological investigations made. Of value in this regard is the finding that there is no correlation between weather conditions and the assimilation of potash as a fertilizer, but that the form and amount of potash and its time of application are of considerable importance. Of equal interest and value are the observations that "lodging" of cereal crops is reduced by increased applications of potash, these being particularly necessary when the dressings of nitrogen and phosphoric acid are large, and

* By Professor Dr. O. Eckstein, Agricultural Research Station, Berlin-Lichterfelde.

that magnesium deficiency may cause severe damage to crops. In the latter instance the inclusion of a fertilizer containing magnesium, *e.g.*, kainit, is recommended. Conclusive evidence has also been obtained of the harmful effects of aluminium ions on the roots of certain crops and that a re-action of less than P_H 5 may bring about their formation. The results of investigations on the effect of potash manuring on the structure of the cotton fibre are also of interest.

In Part III. the investigations on the influence of fertilisers on the chemical composition and nutritional value of food and feeding stuffs are detailed. Part IV. consists of a list of publications issued by the Berlin-Lichterfelde Experiment Station. A valuable subject index, both in German and English, is included. The book is well printed and illustrated, and is replete with tables furnishing data for the discussions in the text.—A.W.R.J.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED MARCH, 1936.

Province, &c.	Disease	No. of Cases up to date since Jan. 1st, 1936	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	2	..	2	..	..	..
	Anthrax	..	..	..	..	..	..
	Rabies (Dogs)	10	1	..	..	..	10
Colombo Municipality	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	..	..	..	..	..	..
	Anthrax	..	..	..	..	..	..
	Rabies	17	6	..	17	..	..
Cattle Quarantine Station	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	..	..	..	..	..	..
	Anthrax	9	3	..	9	..	..
Central	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	409	83	306	3	100	..
	Anthrax	..	..	..	..	..	..
Southern	Rinderpest	FREE					
	Foot-and-mouth disease						
	Anthrax						
Northern	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	53	4	53	..	..	..
	Anthrax	..	..	..	..	..	..
Eastern	Rinderpest	FREE					
	Foot-and-mouth disease						
	Anthrax						
North-Western	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	304	195	181	1	122	..
	Anthrax	..	..	..	..	..	..
	Rabies	15	6	..	1	..	14
North-Central	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	571	31	540	..	31	..
	Anthrax	..	..	..	..	..	..
Uva	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	..	..	..	..	..	..
	Anthrax	..	..	..	..	..	..
	Rabies	2	..	..	1	..	1
Sabaragamuwa	Rinderpest	FREE					
	Foot-and-mouth disease						
	Anthrax						

Government Veterinary Department,
Peradeniya, 16th April, 1936.

M. CRAWFORD,
Government Veterinary Surgeon.

METEOROLOGICAL REPORT—MARCH, 1936

Station	Temperature: Mean Maximum	Temperature: Difference from Average	Temperature: Mean Minimum	Temperature: Difference from Average	Humidity: Day	Humidity: Night (from Minimum)	Amount of Cloud	Rainfall: Amount	Rainfall: No. of Rainy Days	Rainfall: Difference from Average
	°	°	°	°	%	%		Ins.		Ins.
Colombo ..	87·4	−0·4	74·1	+0·4	69	88	5·6	5·29	16	+ 0·42
Puttalam ..	89·9	+0·3	72·7	+0·4	70	95	4·1	3·12	8	− 0·21
Mannar ..	87·9	−2·2	75·8	+0·8	71	86	4·8	6·92	8	+ 5·20
Jaffna ..	88·3	−0·1	76·2	+1·0	69	86	4·6	2·56	9	+ 0·73
Trincomalee ..	85·4	+0·4	76·9	+0·3	74	82	5·4	3·37	7	+ 1·01
Batticaloa ..	85·0	−0·2	74·4	−0·6	80	95	3·8	6·52	13	+ 3·17
Hambantota ..	86·3	−0·2	74·5	+0·6	75	90	4·5	3·18	11	− 0·65
Galle ..	85·7	−0·8	75·3	+0·5	75	91	5·2	3·63	13	− 2·58
Ratnapura ..	90·5	−1·4	72·8	+0·4	72	93	5·4	6·65	20	− 4·30
Anuradhapura ..	88·2	−2·8	72·6	+1·3	68	93	5·2	14·07	12	+10·43
Kurunegala ..	90·1	−2·2	72·3	+0·7	64	93	4·7	16·27	15	+10·29
Kandy ..	87·0	−0·2	69·0	+0·4	68	80	5·0	8·77	14	+ 2·94
Badulla ..	81·1	−0·9	64·9	+0·7	76	97	5·4	6·62	16	+ 1·05
Diyatalawa ..	75·6	−1·3	58·8	+1·0	74	91	5·2	5·09	18	+ 0·14
Hakgala ..	71·3	−0·7	52·6	+1·0	79	91	6·7	9·84	20	+ 3·14
Nuwara Eliya ..	69·6	−0·9	47·4	+1·1	74	93	6·4	3·78	15	− 0·54

The rainfall of March was on the whole above normal. The principal districts reporting deficits were in the extreme south, and in the low-country to the west of the main hill-masses. Several stations up-country also reported slight deficits. Excesses were most marked in the districts between Kurunegala and Anuradhapura, where many stations were over 10 inches above normal. The highest monthly total reported was 20·08 inches, at Lunugala.

Only five daily falls of 5 inches or more were reported, three of them on the 29th, and one on the 30th. The highest was 6·66 inches, at Meeriabedde, on the 29th.

The dry spell which set in at the end of February continued for the first few days of March. Low night temperatures were experienced till the 3rd, particularly up-country, ground frost being reported at Nuwara Eliya on the nights of the 1st-2nd and 2nd-3rd. After this the rainfall increased, and widespread rain, moderately heavy in many places, was reported for the 4th and 5th, mainly as the result of evening thunderstorms. Thunderstorms continued to be fairly frequent during the remainder of the month, the resulting rains being heaviest and most widespread on the 8th-10th, 19th-21st, 26th, 29th-31st.

Mean monthly temperatures were generally below normal by day, and above normal at night. The offsets, however, were usually small. Relative humidity was above normal by day, while at night it was on the whole about the average. The barometric gradient was weak, showing no marked variation from normal, while the pressure was a little above normal. Wind strength was generally a little above normal, while its direction was variable.

H. JAMESON,
Superintendent, Observatory.